DOCUMENT RESUME

ED 039 614 24 CG 005 637

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TITLE An Investigation of Variables Influencing the Delay Retention Effect. The Effect of Form of Information Feedback on Test Conditions on the Delay Retention Effect.
INSTITUTION Chico State Coll., Calif.
SPONS AGENCY Office of Education (DHEW), Washington, D.C. Bureau of Research.
BUREAU NO BR-8-I-004
PUB DATE Jun 70
GRANT OEG-9-8-081004-0125(010)
NOTE 46p.

EDRS PRICE EDRS Price MF-$0.25 HC-$2.40
DESCRIPTORS *Experiments, *Feedback, *Learning, Recall (Psychological), Recognition, Research, *Retention, Tests, *Time Factors (Learning)

ABSTRACT

The purpose of this study is twofold: (1) to separate variables combined in the forms of Information Feedback (IF); and (2) to identify additional variables in the effect upon retention of 24 hour delay of feedback. In two of the experiments, the effect of IF delay, immediate test conditions, and different forms of IF upon seven day retention, measured by a recall and recognition test, were investigated. Undergraduates were subjects and learning material was a series of 32 multiple choice items, with a definition as a stem and four uncommon words as alternatives. Results revealed that superior retention with delayed IF is due to the fact that after a delay subjects acquire more information and when this information can be used on the retention test, retention is facilitated. Experiment three investigated similar effects but subjects' responses to IF were manipulated. It was concluded that the way in which subjects respond to IF is an important determiner of retention. (Author/EK)

FINAL REPORT
Project No. 8-1-004
Grant No. OEG-9-8-081004-0125 (010)

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June 1970

U. S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
Bureau of Research

Final Report

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An Investigation of Variables Influencing the Delay Retention Effect

The Effect of Form of Informative Feedback and Test Conditions on the Delay Retention Effect

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June 1970

The research reported herein was performed pursuant to a grant with the Office of Education, U. S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

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Summary

Recent studies indicate that retention following 24-hr. delay of informative feedback (IF) is superior to that following immediate presentation of IF, although there is no significant effect upon immediate retention, or acquisition. The interpretation of these findings is not clear. One possibility is that this effect is due to events occurring during the delay interval and that with delayed IF the correct stimulus-response association is strengthened during acquisition, resulting in improved retention. A second interpretation is that superior retention with 24-hr. delay of IF is due to factors operating at or following the presentation of IF and that what Ss learn with immediate and delayed IF actually differs.

Three experiments investigated the following questions about the effect of 24-hr. delay of IF. Does this effect differ with the form of IF and, if so, what cues are most likely to be utilized during feedback to facilitate retention? Does it depend upon the form of retention tests, i.e., recall or recognition? Does it differ with the presence and form of an immediate retention test? In all three experiments all forms of IF provided the opportunity for the association between the stem and the correct alternative. The concern was with the effect of additional information presented at feedback.

Two experiments investigated the effect of delay of IF (0-min., 20-min., 24-hr.); immediate test conditions (nothing; recall; recognition); and different forms of IF upon 7-day retention, measured by both a recall and recognition test. Undergraduates were Ss; and learning material was a series of 32 multiple-choice items, with a definition as a stem and four uncommon English words as alternatives. In Experiment I four forms of IF differed in two ways: (a) the number of alternatives included; and (b) the presence or absence of redundant cues, not included on the tests. In Experiment II two forms of IF included the stem with the correct and incorrect alternatives (a) with the correct alternative identified and definitions of each incorrect alternative; or (b) with a cue which Ss could use to find the correct alternative. Superior retention with delayed IF, on both a recall and recognition test, varied with the form of IF and the immediate test condition. Following an immediate recognition test, retention was superior with delayed feedback when IF was in variable form but not when it was redundant. When IF was a cue directing the Ss' attention to all alternatives, retention was superior with delayed feedback only with no immediate test. When IF was a cue, following an immediate test retention for Ss with immediate feedback improved and delayed feedback was no longer superior. These findings were interpreted as supporting the hypothesis that superior retention with delayed IF is due to the fact that after a delay interval Ss acquire more information at IF and that when this information can be used on the retention test, retention is facilitated.

Experiment III investigated the question: can effects similar to those of delayed IF be obtained by manipulating Ss' responses to IF. The Ss reactions to IF were manipulated by the form of IF and

instructions and were designed to compare the effect of: (a) learning the correct alternative only; (b) learning the correct and the incorrect alternatives; and (c) organizing the material. Except for the feedback conditions, the design and materials were identical to those of Experiments I and II. Following an immediate test, retention on a recall test was superior when Ss had been instructed to study the incorrect in addition to the correct alternative. On the recognition test, retention was superior when Ss had been instructed to study the correct alternative only. These results were interpreted as supporting the hypothesis that how Ss respond to IF is an important determiner of their retention of the material. Also, they were seen as supporting the interpretation that retention with minimal cues is facilitated when Ss have acquired information in addition to the correct stimulus-response members.

Introduction

Many educational practices incorporate the principle of the superiority of immediate informative feedback (IF) both for initial learning and for retention. These practices include most programs for teaching machines and programmed texts, but they are also employed in classroom activities such as returning tests, replying to students' questions, daily assignments and, in general, imparting information in the classroom. Recent studies question the general superiority of immediate IF with meaningful verbal material. Experimental findings indicate that there is no detrimental effect upon acquisition with a delay of IF unless the delay interferes with conditions necessary for association of the stimulus and the correct response alternative, for example, the association of the question with the correct answer (1, 2, 7, 10). Thus a number of studies in which IF includes the entire item have found no difference in measures of acquisition when IF was presented immediately or after a short (10-sec.) or longer (24-hr.) delay interval (3, 4, 5, 6, 13, 15, 12).

More interesting are the findings that under some conditions retention is superior when IF is delayed rather than presented immediately after the response. Brackbill and her associates (3, 4, 5, 6) have consistently found superior retention both one and seven days after acquisition when a 10-sec. delay of feedback was used during acquisition. These studies have used children as Ss and a variety of two-choice discrimination tasks, including pictures of familiar objects, nonsense bi-grams, meaningful words, and English-French equivalents. In general, they have found that the delay retention effect is greater with more complex materials. In Brackbill's studies feedback consisted of the combination of tangible reinforcement (marbles which were exchanged for a toy); knowledge of results (a click or a buzz if the S's response had been correct or incorrect respectively); and informative feedback (a light over the correct response). Markowitz and Renner (10) investigated the delay retention effect by separating the tangible reinforcement from the combined auditory signal and IF used by Brackbill. With tangible reinforcement only, they found the delay retention effect when feedback was the combination used by Brackbill and also when Ss received immediate tangible reinforcement and delayed auditory signal and IF. Markowitz and Renner concluded that the delay retention effect was due to the unusual combination of feedback used by Brackbill. They suggested that when this combined feedback was delayed, Ss had to look at the light to determine the correct response and that watching the light increased the memory of the correct alternative; whereas with immediate feedback, Ss did not have to look at the light to determine the correct response. Sturges, Sarafino, and Donaldson (15) investigated the delay retention effect with a procedure similar to that used by Brackbill and by Markowitz and Renner, except that feedback consisted only of IF, the light over the correct alternative. Their findings were similar to those of Brackbill and of Markowitz and Renner; superior savings were shown at relearning by Ss receiving delayed IF during acquisition. This finding of the delay retention effect when the only feedback was IF questions the conclusions of Markowitz and Renner.

Lintz and Brackbill (8) investigated the delay retention effect with adults with conditions equivalent to those with children and found equivocal results. With nonsense bi-grams presented in a

two-choice discrimination task, there was no difference in retention between immediate and delayed feedback during acquisition. The delay retention effect was found when the same bi-grams were presented in a paired-associate task.

Brackbill (3) investigated her hypothesis that the delay retention effect occurred because more task-related covert responses were made during the 10-sec. delay interval, were subsequently reinforced, and thus were available at retention. An extraneous task was introduced during the 10-sec. interval preceding feedback for Ss in the delay group; the same task was introduced following feedback for Ss receiving immediate feedback. There was no effect of the extraneous task upon either acquisition or retention for Ss with delayed feedback. When the task was introduced right after immediate feedback, however, a decrement both at acquisition and at retention resulted. This finding suggests that the delay retention effect is due to factors operating during or immediately following IF rather than to factors occurring during the delay interval.

Recently, a few studies have investigated the effect of a 24-hr. delay of IF, with only one acquisition trial, i.e., presentation of IF, and the major dependent variable a retention measure. Thus, Ss have been presented a series of items and made an initial "guessing" response to each; and then 24-hr. later they have been presented the series of informative feedback. This 24-hr. delay condition has been compared either with one in which feedback is presented immediately item-by-item (13) or with a condition in which the series of feedback is presented immediately after the series of items (12). In some studies Ss have been tested immediately for acquisition (11, 12, 13) and in all they have been tested several days later for retention. The general results of these investigations have been that at acquisition there is no significant difference between delayed and immediate feedback but on later retention delayed feedback is superior.

Although the effects of a 24-hr. delay of feedback have some similarity to those with a shorter delay interval, these investigations differ in several important ways, and there is reason to question that they can be directly compared. However, the effects of a 24-hr. delay interval are important for at least two reasons. First, the operations are those of a delay of IF and thus the results offer information on the generality of findings with shorter delay intervals. Second, the effect of the longer delay interval upon retention is important in understanding factors involved in long-term retention.

Sturges and Crawford (14) investigated the effect upon 7-day retention of a 24-hr. delay of IF, with college students as Ss. They found that the delay retention effect was a function of the meaningfulness of material and the type of IF. When feedback indicated the correct answer, the delay retention effect was found with factual items and with material requiring inductive generalizations. There was no difference in retention between immediate and delayed IF for nonsense materials when IF was the correct answer or with meaningful material when IF was only a cue suggesting the correct answer. Their interpretation was that exploration of meaningful material, prior to or at feedback, facilitates retention. They suggested that such exploration was encouraged by delaying the presentation of the correct

alternative or by presenting a cue which would directly promote such exploration of the material.

Sassenrath and Yonge (12) investigated the effect upon 5-day retention with college students as Ss of a 24-hr. delay of IF, presence or absence of the stem at IF, and a set to remember. Their results indicated superior retention with delayed IF, the stem of the question, and the retention set, but there were no significant interactions among these variables. More (11) compared 7-day retention with Junior High School students following immediate IF, 2-hr., 24-hr., and 4-day delay of IF and found superior retention with 24-hr. delay of IF.

An important question in investigating factors that lead to improved retention with 24-hr. delay of IF is: what are Ss actually learning with immediate and delayed IF? One possibility is that this effect is due to events occurring during the delay interval and that in both conditions Ss are learning primarily or solely the correct stimulus-response association. Thus, with delayed IF the correct members would be strengthened during acquisition, resulting in improved retention. With this hypothesis the superiority of delayed IF should occur on immediate retention or acquisition, which has not been found. However, it may be that Ss in both conditions learn the same thing, and initially to about the same level, but that during the delay interval a process occurs that is similar to the Zeigarnik effect of an incomplete task, making the correct stimulus-response association a more salient aspect and thus resulting in better retention.

A second possibility is that the difference in retention with immediate and 24-hr. delay of feedback is due to factors operating at or following the presentation of IF and that what Ss learn with immediate and delayed IF actually differs. It may be that with delayed IF Ss respond to more cues or stimulus aspects of IF, thus learning more about the item; and that when these cues can be used in retention, delay improves retention. This hypothesis suggests that Ss respond differently to IF when it is presented immediately after the response than they do when it is presented after a delay interval; and that the way they respond to the IF determines what they learn and, therefore, their retention of the material. With this hypothesis there are also two possibilities. One is that the additional learning postulated to occur with delayed feedback results in more precise discrimination of the correct choice due to S having learned both the incorrect and the correct alternatives. This interpretation would be similar to concept identification in which Ss learn to identify the negative as well as the positive instances of the concept. A second possibility with this hypothesis is that the additional learning postulated with delayed IF results in higher-order organization of the items. Recent work by Mandler (9) indicates that retention of verbal material is a function of the organization of the material, i.e., superior recall is found when Ss have identified stable relationships among the verbal units. In his studies, Mandler measured "free recall" of individual words. However, it may be that in verbal learning tasks in which S must learn to discriminate the correct from the incorrect alternatives, retention is improved as he explores and organizes the learning material more completely. According to this interpretation,

the effect of delayed feedback would depend upon: (a) stimulus aspects present during feedback; and (b) the relevance of these stimuli to the retention test.

Some support for this second interpretation was found in an earlier experiment (13). Superior retention with 24-hr. delay of informative feedback occurred when feedback included the incorrect in addition to the correct alternative but not when it included the correct alternative only. Thus, these findings support the hypothesis that the effect of 24-hr. delay of feedback is due to factors operating at or following the presentation of feedback rather than to events occurring during the delay interval. However, the inclusion of incorrect alternatives was confounded with the presence of spatial cues and letters of the alternatives, both of which were directly relevant to the retention tests. Thus, it is not clear whether these results were due to the redundancy of feedback cues, to the utilization of more cues in general, and/or to the knowledge of the specific alternatives.

Three experiments were conducted to provide a more thorough understanding of variables involved in the delay retention effect. One purpose was to separate the variables combined in the forms of IF in Sturges' (13) experiment. A second purpose was to identify some additional variables involved in the effect of 24-hr. delay of feedback upon retention. Thus, the experiments investigated the following questions about the effect of 24-hr. delay of feedback. Does this effect differ with the form of feedback and, if so, what cues are most likely to be utilized during feedback to facilitate retention? Does it depend upon the form of retention tests, i.e., recall or recognition? Does it differ with the presence and form of an immediate retention test? In all three experiments all forms of feedback provided the opportunity for the association between the stem and the correct alternative. The concern was with the effect of additional information presented at feedback.

Experiment I

Experiment I investigated the effect of four forms of feedback, which differed in two ways: (a) the number of alternatives included; and (b) the presence or absence of redundant cues, position and the letters of the alternatives. The redundant stimuli were not included on either the immediate or 7-day recognition test and thus were not directly relevant to the tests.

Three delay intervals were compared: 0-min. delay, in which feedback was presented immediately item-by-item; 20-min. delay, in which the series of feedback was presented immediately after the series of items; and 24-hr. delay, in which Ss received the series of items on the first day and returned 24 hours later for the series of feedback. Previous studies have found superior retention for 24-hr. delay compared with both a condition in which feedback was presented immediately item-by-item (13, 14) and with a condition in which the series of feedback was presented immediately after the series of items (12). This latter condition is not immediate IF in the sense of feedback following immediately upon the response but, rather, it is a 20-min. experimentally filled delay interval. However, in the 20-min. delay condition the sequence of experimental events is

the same as in the 24-hr. delay, while in the 0-min. delay, the sequence is different. Thus, these three delay intervals permit evaluation of the effect of the sequence of experimental events (0-min.) and experimental activity during the delay interval (20-min.) in addition to the length of delay.

Retention was measured by both a recall and a recognition test to provide additional information about what Ss are learning with different delay intervals and different forms of feedback. If the delay retention effect is found only with a recognition test, it would seem to be dependent upon presentation of the entire item on the test. Thus, it may be due to minimal learning, to discrimination among alternatives on a recognition level, etc. However, if the delay retention effect is a result of higher-order organization of the material, then it should be found with a recall test as well as with a recognition test. That is, if Ss have actively organized the material by identifying relations among the stem, the correct, and the incorrect alternatives, they should then be able to recall it with minimal cues at retention.

The fourth variable investigated is primarily of methodological interest, but it also has implications for explanation of the delay retention effect. Both Sturges (13) and Sassenrath and Yonge (12) included an immediate and a 7-day retention test on the same Ss. Thus, Ss in both immediate and delayed IF groups had an additional presentation of the material following IF (the immediate retention test), thereby confounding the measure of 7-day retention. It would be expected that later retention in both groups would be improved with this additional presentation of the material, counteracting to some extent the effect of factors operating at acquisition. Furthermore, it would be predicted that the additional presentation would decrease the delay retention effect, if this effect is due to the fact that Ss with delayed IF explore the material at the time feedback is presented while Ss with immediate IF do not. That is, it would be likely that Ss in both groups would explore the material at or following the presentation of the immediate retention test. Thus, any superiority of retention due to additional exploration of the material by the delay group at the time of IF would be reduced. The present study investigated three immediate test conditions. Subjects received either no immediate test, an immediate recall test, or an immediate recognition test; and all Ss were given both a recall and a recognition test at seven days. This provided a measure of immediate retention, or acquisition, and also evaluation of the effects of immediate tests upon the 7-day retention tests.

Method

Design. Three variables were combined factorially: four forms of feedback [Right-Wrong Redundant (RW+); Right Redundant (R+); Right-Wrong Variable (RW); Right Variable (R)]; three delay intervals (0-min., 20-min., 24-hr.); and three immediate test conditions [nothing, recall (Re-1), recognition (Rcg-1)] All Ss had two 7-day retention tests, recall and recognition. Subjects were 468 undergraduates, fulfilling a course requirement, who were randomly assigned with 13 Ss in each of the 36 groups.

Apparatus and learning material. Learning material was a series of 32 multiple-choice items, with a definition as a stem and four uncommon English words as alternatives. The task was to learn the correct word for each definition. The items were selected with eight from each of four word categories: concrete nouns; abstract nouns; adjectives; and verbs. For the initial presentation, each item consisted of the stem with each alternative below it and preceded by a letter (a, b, c, d). Each form of feedback included the stem and the correct alternative, which was underlined and had an asterisk to its left. Two forms of feedback had the stem and the correct alternative only (R, R+); and two had the stem with the correct and all incorrect alternatives (RW, RW+). For each of these one was redundant, with the letters and each alternative in the same position as in the initial presentation. For the two variable forms of feedback, each alternative was in a randomly different position and without the letters. See Appendix A for sample item and different forms of feedback.

The items were presented in the same random order for the initial and IF presentations. On both immediate and 7-day tests the items were in different random orders, and on the recognition tests the alternatives were in randomly different positions with no letters preceding them. The recognition test presented the stem and all four alternatives; the recall test presented the stem only; and in both tests Ss wrote the correct alternative.

All material was presented on 2 in. X 2 in. slides by a Kodak Carousel slide projector, with presentation intervals automatically controlled by electronic timing units. For the initial presentation and the retention tests Ss recorded their answers on special devices, designed so that the answer was turned out of view immediately.

Procedure. Subjects in all groups participated in the following three phases of the experiment: initial presentation of the material with the Ss answering each item; presentation of IF; and both 7-day retention tests. For Ss with 0-min. and 20-min. delay of IF, the initial presentation of the material and the presentation of IF occurred in the same session. For the 0-min. groups the sequence for this initial session was: item 1 (15 sec.); write the answer (15 sec.); IF for item 1 (15 sec.); rest (10 sec.); item 2 (15 sec.); etc. For the 20-min. delay groups the series of items was followed immediately by the series of IF: item 1 (15 sec.); write the answer (15 sec.); item 2 (15 sec.). . . item 32 (15 sec.); write the answer (15 sec.); IF for item 1 (15 sec.); rest (10 sec.); etc. For the 24-hr. delay groups the sequence of events was the same as for the 20-min. delay groups except that Ss received the series of items on the first day and returned 24 hours later for the series of IF. In all three delay conditions, Ss had the same number, type, and length of presentation of the initial material and of IF. For Ss in the immediate test group, this retention test (Re-1; Rcg-1), was given immediately after the series of IF: on Session 1 for the 0- and 20-min. delay groups; and on Session 2 for the 24-hr. delay groups. All Ss were given a recall test followed by a recognition test seven days after the presentation of IF. In both the recognition test seven days after the presentation of IF. In both the recognition and the recall tests, the temporal sequence for all groups was: item 1 (15 sec.); write the answer

(15 sec.); item 2 (15 sec.); etc. See Appendix B for the temporal sequence of experimental events.

Results

Immediate Tests. Figure 1 presents the mean correct for each group for each of the immediate tests. Table 1 presents the summary of the analysis of variance of these data. The overall effect of

Table 1

Summary Analysis of Variance, Immediate Tests, Experiment 1

Source	SS	df	MS	F
Feedback (F)	29.52	3	9.84	1.68
RW+ > RW; R > R+ ($F_1 \times F_2$)	28.32	1	28.32	4.84*
Delay (D)	168.51	2	84.25	14.40***
(24- + 20-) > 0- (D_1)	160.03	1	160.03	27.47***
Test (T)	6526.70	1	6526.70	1115.68***
F x D	38.30	6	6.38	1.09
F x T	7.40	3	2.47	.42
D x T	41.97	2	20.98	3.59*
D_1 x T	41.03	1	41.03	7.02**
F x D x T	31.69	6	5.28	.90
error	1683.73	288	5.85	

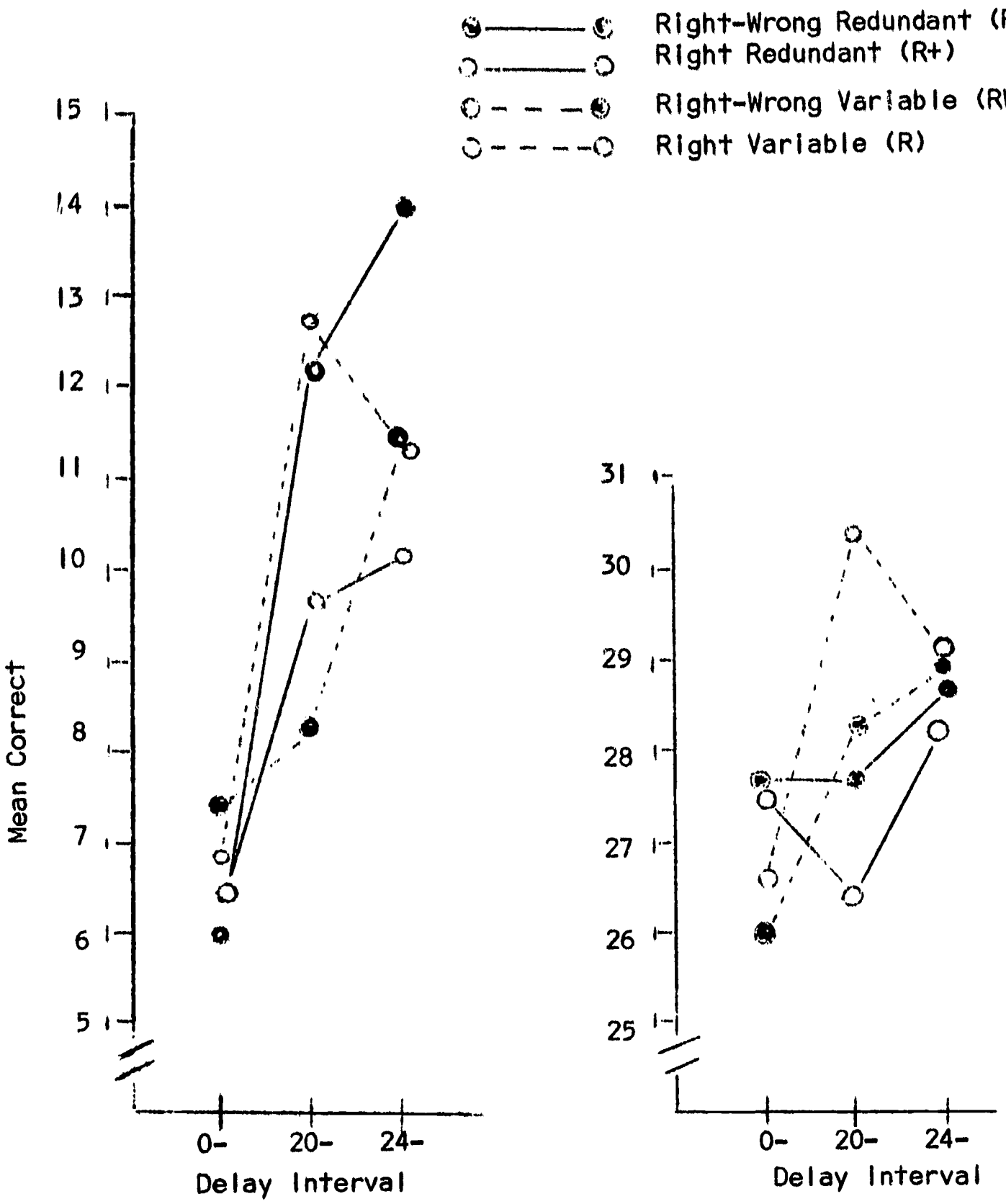
*p < .05
**p < .01
***p < .001

NOTE:

The overall effect of delay was divided into two orthogonal components:
D_1 (24-hr. + 20-min.) vs. 0-min.
D_2 24-hr. vs. 20-min.

The overall effect of form of feedback was divided into three orthogonal components:
F_1 RW (RW+, RW) vs. R (R+, R)
F_2 Variable (RW, R) vs. Redundant (RW+, R+)
$F_1 \times F_2$

The overall effect of immediate test condition (on 7-day retention) was divided into two orthogonal components:
T_1 The combined tests (Re-1 + Rcg-1) vs. no test
T_2 Re-1 vs. Rcg-1



A. Recall Test

B. Recognition Test

Fig. 1 Mean Correct, Immediate Retention Tests, Experiment I for Delay Conditions and Four Forms of Feedback

delay was divided into two orthogonal components: D_1, (24-hr. + 20-min.) vs. 0-min.; and D_2, 24-hr. vs. 20-min. The effect of form of IF (F) was divided into three orthogonal components: F_1, Right Wrong (RW+, RW) vs. Right only (R+, R); F_2, variable (RW, R) vs. redundant (RW+, R+); and the interaction of these two components.

The combined delay groups (24-hr. + 20-min.) were superior to 0-min. delay, and this effect was more marked on the recall test than on the recognition test. These results are contrary to those of other studies, but this difference can be attributed to the fact that the effect of delay was found primarily on the recall test and for the combined 24-hr. and 20-min. delay groups only. In previous studies reporting no effect of delay on immediate retention, either a recognition test has been used or a 24-hr. delay was compared with 20-min. delay.

There was a significant interaction between the forms of feedback. When all alternatives were presented at IF redundant was superior to variable but when the correct alternative only was presented, variable was superior to redundant. Also, performance was significantly greater on the recognition test than on the recall test.

Seven-day retention tests. Figures 2, 3, and 4 present the mean correct for each of the groups and each of the 7-day retention tests. Table 2 presents the summary of the analysis of variance of these data. The same orthogonal comparisons were made as for the immediate tests. Also, the effect of the immediate test condition was divided into two components: T_1, the combined tests (Re-I + Rcg-I) vs. no test; and T_2, Re-I vs. Rcg-I.

There was a significant overall effect of delay, with both components significant. The combined 24-hr. and 20-min. delay was superior to 20-min. delay. This latter finding is consistent with that of Sassenrath and Yonge (12) in which they compared 24-hr. delay with an immediate group similar to the 20-min. delay in the present study.

As on the immediate tests, the superiority of the combined delay groups was greater on the recall test than on the recognition test. Also, overall performance on the recognition test was significantly better than on the recall test.

There was an overall significant effect of the immediate test condition, with both components significant. Seven-day retention for the combined immediate test groups was superior to that with no immediate test; and retention following an immediate recognition test was superior to that with an immediate recall test. There was also a significant interaction between immediate test and form of 7-day test (T X R). The superior retention following the immediate recognition test (Rcg-I) was greater on the 7-day recognition test than on the 7-day recall test (see Figures 3 and 4).

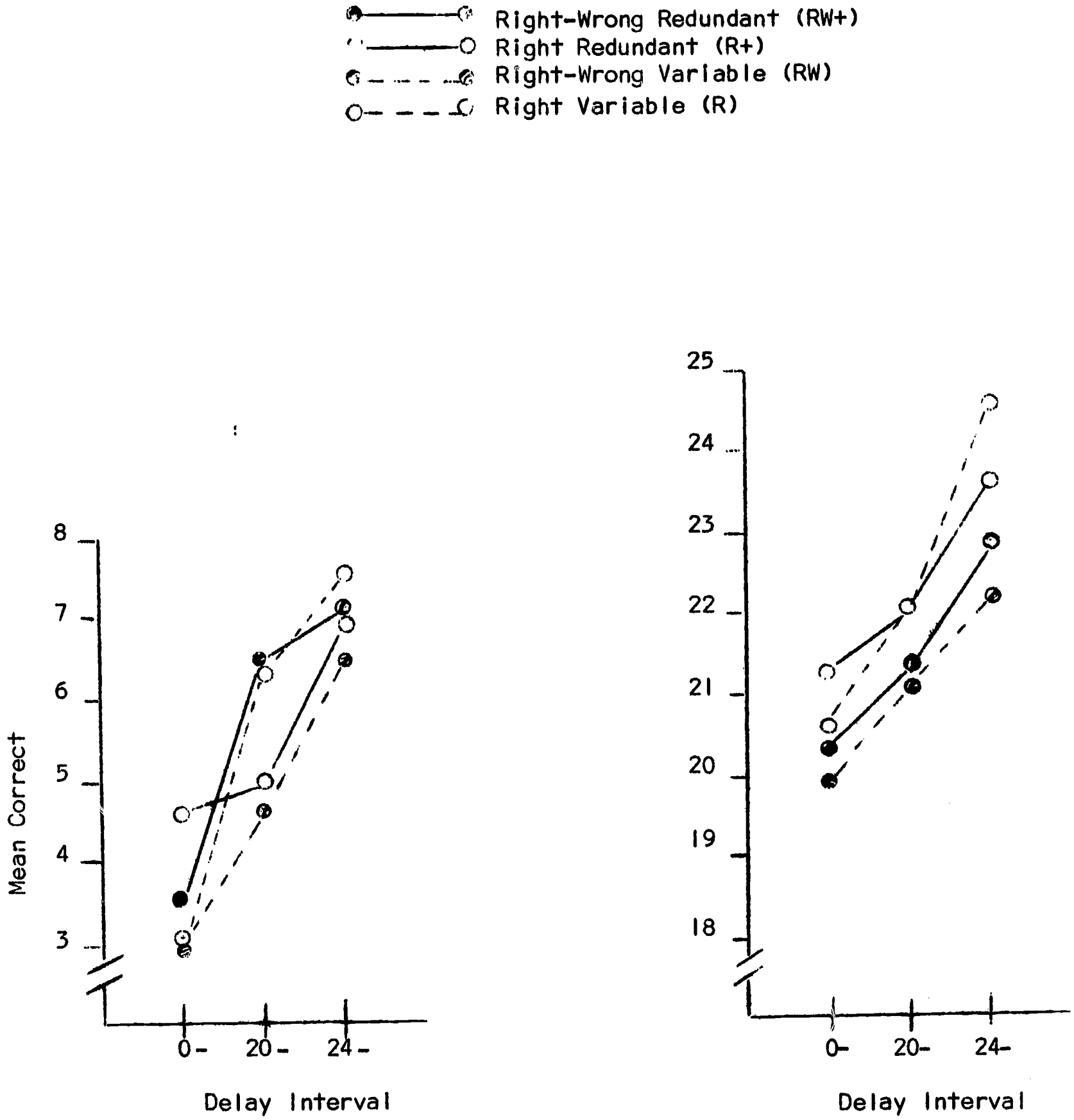
There was no overall effect of form of feedback, but there were some significant interaction effects between delay, form of feedback, and the other variables. One component of the interaction of form of feedback and type of retention test (F X R) was significant. Performance on the recall test was best when IF included all

Table 2

Summary Analysis of Variance, 7-day Retention Tests, Experiment 1

Source	SS	df	MS	F
Feedback (F)	48.92	3	16.31	1.70
(R + R+) > (RW + RW+) (F_1)		1	31.98	3.33
Delay (D)	387.15	2	193.57	20.14***
(24- + 20) > 0- (D_1)		1	292.13	30.40***
24- > 20- (D_2)		1	95.02	9.89**
Test, Immediate (T)	682.90	2	341.45	**
(Re-1 + Rcg-1) > none (T_1)	559.04	1	559.04	57.69***
Rcg-1 > Re-1 (T_2)	123.85	1	123.85	12.89***
F x D	27.36	6	4.56	.47
F x T	26.19	6	4.36	.45
D x T	61.14	4	15.29	1.59
D_1 x T_1	30.66	1	30.66	3.19
F x D x T	130.42	12	10.87	1.13
D_1 x F_2 x T_2		1	54.17	5.64*
error (between)	4151.27	432	9.61	
Retention Test (R)	15,794.90	1	15,794.90	9515.00***
F x R	11.63	3	3.88	2.33
F_1 x R		1	8.46	6.00*
D x R	9.31	2	4.66	2.80
D_1 x R		1	8.82	5.31*
T x R	98.16	2	49.08	29.56***
T_2 x R		1	96.98	58.41***
F x D x R	13.14	6	2.19	1.32
D_2 x (F_1 x F_2) x R		1	6.88	4.14*
F x T x R	12.19	6	2.03	1.22
D x T x R	2.48	4	0.62	.37
D x F x T x R	13.47	12	1.12	.67
error (within)	717.23	432	1.66	

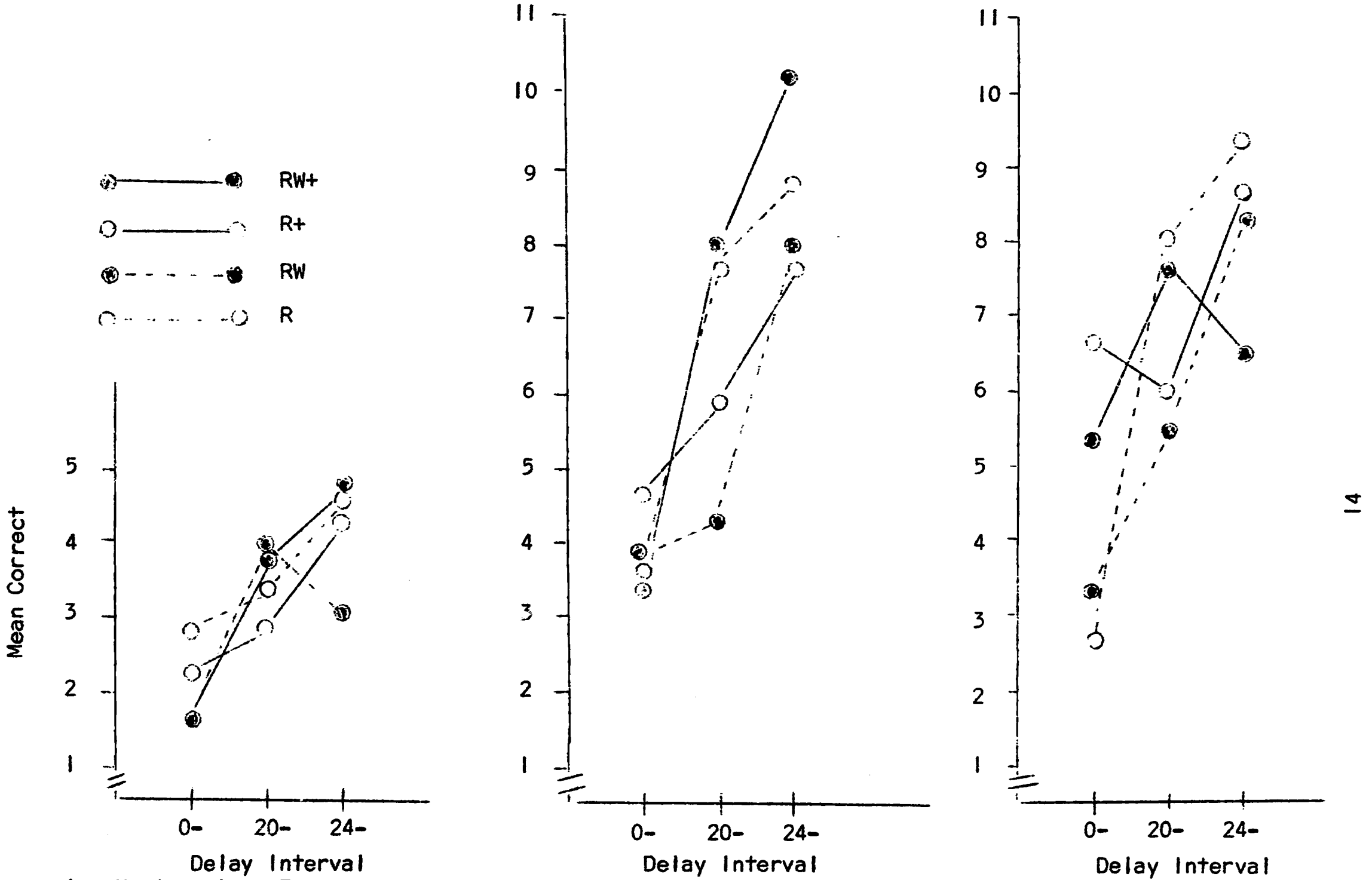
*p < .05
**p < .01
***p < .001



A. Recall Test

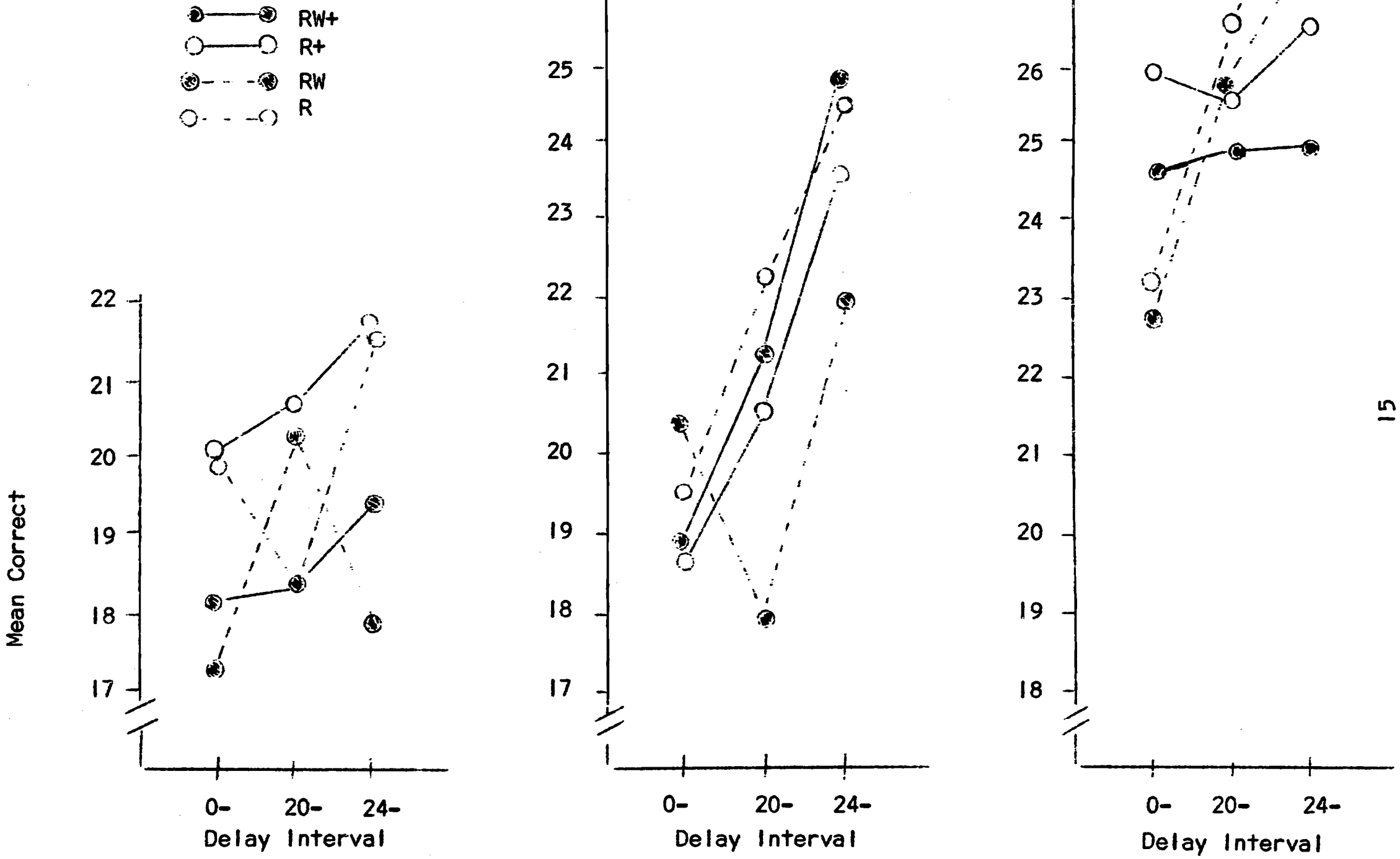
B. Recognition Test

Fig. 2 Mean Correct, 7-day Retention Tests, Experiment I with Immediate Test Conditions Combined, for Delay Conditions and Four Forms of Feedback



A. No Immediate Test B. Immediate Recall Test C. Immediate Recognition Test

Fig. 3 Mean Correct, 7-day Recall Tests, Experiment I: Delay, Feedback and Immediate Test Conditions



A. No Immediate Test B. Immediate Recall Test C. Immediate Recognition Test

Fig. 4 Mean Correct, 7-day Recognition Tests, Experiment I: Delay, Feedback, and Immediate Test Conditions

alternatives (RW, RW+), and on the recognition it was best for IF with the correct alternative only (R, R+).

One component of the interaction of form of IF, delay, and immediate test (F X D X T) was significant. The superiority of the combined 24-hr. and 20-min. delay groups differed with the form of feedback and the immediate test conditions. This is most readily seen in Figure 4. Following an immediate recognition test there is a marked relationship between delay and variable-redundant form of IF. Superior retention with delay occurred when feedback was in variable form but not when it was redundant. Following an immediate recall test the relationship between delay for form of IF is quite different. The slight superiority of delay with redundant feedback is due almost solely to the inferiority of one group, Right-Wrong Variable, 20-min. delay.

One component of the interaction between form of IF, delay, and form of retention test (F X D X R) was also significant. The superiority of 24-hr. delay to 20-min. delay was a function of the type of retention test and the interaction of RW-R and variable-redundant forms of feedback. As can be seen in Figure 2, this effect is accounted for primarily by the greater superiority on the 7-day recall test with Right-Wrong Variable (RW) than with Right-Wrong Redundant (RW+) and with Right Redundant (R+) than with Right Variable (R). The opposite relationship occurred on the 7-day recognition test, although to a lesser degree.

Discussion

According to these results, the superiority of the combined delay conditions did differ with the form of feedback and the immediate test conditions. These findings are consistent with the prediction that the effect of delayed feedback depends upon the stimulus aspects present during feedback and the relevance of these stimuli to the retention test. With redundant feedback, where the additional information was not relevant to the test, retention did not vary with delay. With variable forms of feedback, there was a marked superiority of delayed feedback. These results are consistent with those of the earlier study (13) in that in both studies the delay retention effect was found when IF presented stimuli relevant to both an immediate and 7-day test. However, in the present study the delay retention effect occurred for both variable forms of IF, that with all alternatives and that with the correct alternative only. Thus, it would seem that the delay retention effect does not depend upon the presentation of the incorrect alternatives <u>per se</u> but rather upon the number of relevant cues presented at IF.

The fact that the relationship between the delay retention effect and variable-redundant forms of IF was found with both 7-day retention measures indicates that the effect is not dependent upon the form of the test at 7 days. That is, there is no evidence that presentation of the entire item on the 7-day test either facilitated or interfered with this effect. However, the form of the immediate test did make a difference. Apparently, the differential effect of delay with different forms of feedback depends upon the relationship between information presented at feedback and on the immediate test.

Experiment II

Experiment II investigated the effect of delay as a function of two different forms of feedback. One form of feedback was selected to provide more information on what cues are utilized to facilitate retention and presented more additional information, the definition for each incorrect alternative. This condition contrasted with both Right Wrong-Variable and Right Wrong-Redundant in Experiment I. The additional information here is neither the same as in the initial presentation nor directly relevant to the recognition tests.

The second form of feedback provided a more direct test of the hypothesis that superior retention with delay occurs because Ss respond to all information present at feedback after a delay interval but not when feedback is immediate. In this form of feedback the entire item was presented, the correct alternative was not indicated, but a cue was included which the S could use to find the correct alternative. With this form of feedback Ss in both immediate and delay conditions should be directed to explore all alternatives. Thus, if this is the factor producing the delay retention effect, the superiority of delay should disappear.

Method

Design. Three variables were combined factorially; two forms of feedback [Right Wrong Definitions (RW-D); and Right Wrong Cue (RW-C);]; three delay intervals (0-min., 20-min., and 24-hr.); and three immediate test conditions [nothing, recall (Re-I), recognition (Rcg-I)]. All Ss had both 7-day retention tests, recall and recognition. Subjects were 180 undergraduates fulfilling a course requirement, randomly assigned with 10 Ss in each of the 18 groups.

Learning material and procedure. All material and procedures were identical to Experiment I except for the form of feedback and the length of presentation of IF. For feedback consisting of Right Wrong Definitions, the entire item was presented, the correct alternative was underlined and asterisked, and a definition was included after each incorrect alternative. For feedback consisting of Right Wrong Cue the entire item was presented, the correct alternative was not indicated, but a cue was included which S could use to find the correct alternative. For example, for the item where the stem was TO REPEAT SENSELESSLY and the correct alternative was VERBIGERATE, the cue was VERBUM = WORD AS IN VERB; -ATE = TO MAKE. In both forms of feedback the alternatives were in randomly different positions without letters and thus were also variable. For all groups IF was presented for 18 sec. All other temporal intervals were the same as in Experiment I.

Results

Immediate tests. Figure 5 presents the mean correct for each group for each of the immediate tests. Table 3 presents the summary of the analysis of variance of these data. As in Experiment I the overall effect of delay was divided into two orthogonal components: D_1 (24-hr. + 20-min.) vs. 0-min.; and D_2 24-hr. vs. 20-min.

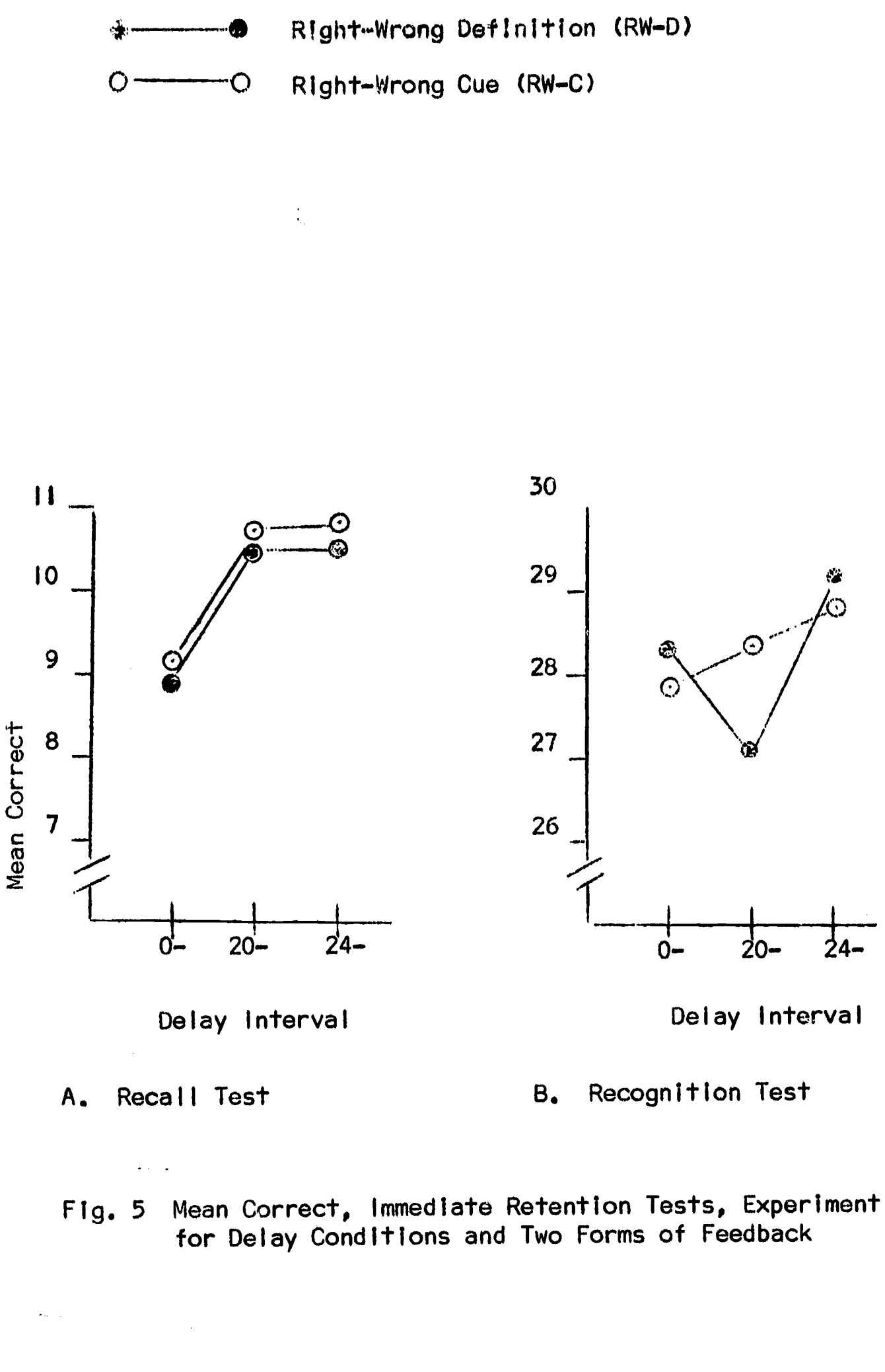


Fig. 5 Mean Correct, Immediate Retention Tests, Experiment II for Delay Conditions and Two Forms of Feedback

Table 3

Summary Analysis of Variance, Immediate Tests, Experiment II

Source	SS	df	MS	F
Feedback (F)	0.21	1	0.21	< 1
Delay (D)	8.45	2	4.23	< 1
Test (T)	2475.21	1	2475.21	405.77***
F x D	1.08	2	0.54	< 1
F x T	0.03	1	0.03	< 1
D x T	4.88	2	2.44	< 1
F x D x T	1.20	2	0.60	< 1
error	659.10	108	6.10	

***$p < .001$

The only significant effect was that performance on the recognition test was superior to that on the recall test. There was no reliable effect of delay or form of feedback.

Seven-day tests. Figures 6, 7, and 8 present the mean correct for each group for each of the tests. Table 4 presents the summary of the analysis of variance of these data. As in Experiment I, the effect of the immediate test condition was divided into two components; T_1, the combined tests (Re-I + Rcg-I) vs. no test; and T_2, Re-I vs. Rcg-I.

Overall retention for the combined 24-hr. and 20-min. delay groups was significantly greater than that for 0-min. delay; but there was no reliable overall difference between 24-hr. and 20-min. delay. The overall effects of the immediate test conditions and the type of retention test were the same as in Experiment I. Retention was significantly better on the recognition test than on the recall test and also it was superior following the combined immediate tests to that with no immediate test. Following the immediate recognition test retention was better than following the immediate recall test; and this effect was significantly greater on the recognition test than on the recall test.

Also, as in Experiment I, there was no overall effect of the form of feedback but there were some significant interaction effects between delay, form of feedback, and the other variables. One component of the interaction between form of IF, delay and immediate test condition (F x D x T) was significant. The effect of the immediate tests upon the superiority of the combined 24-hr. and 20-min.

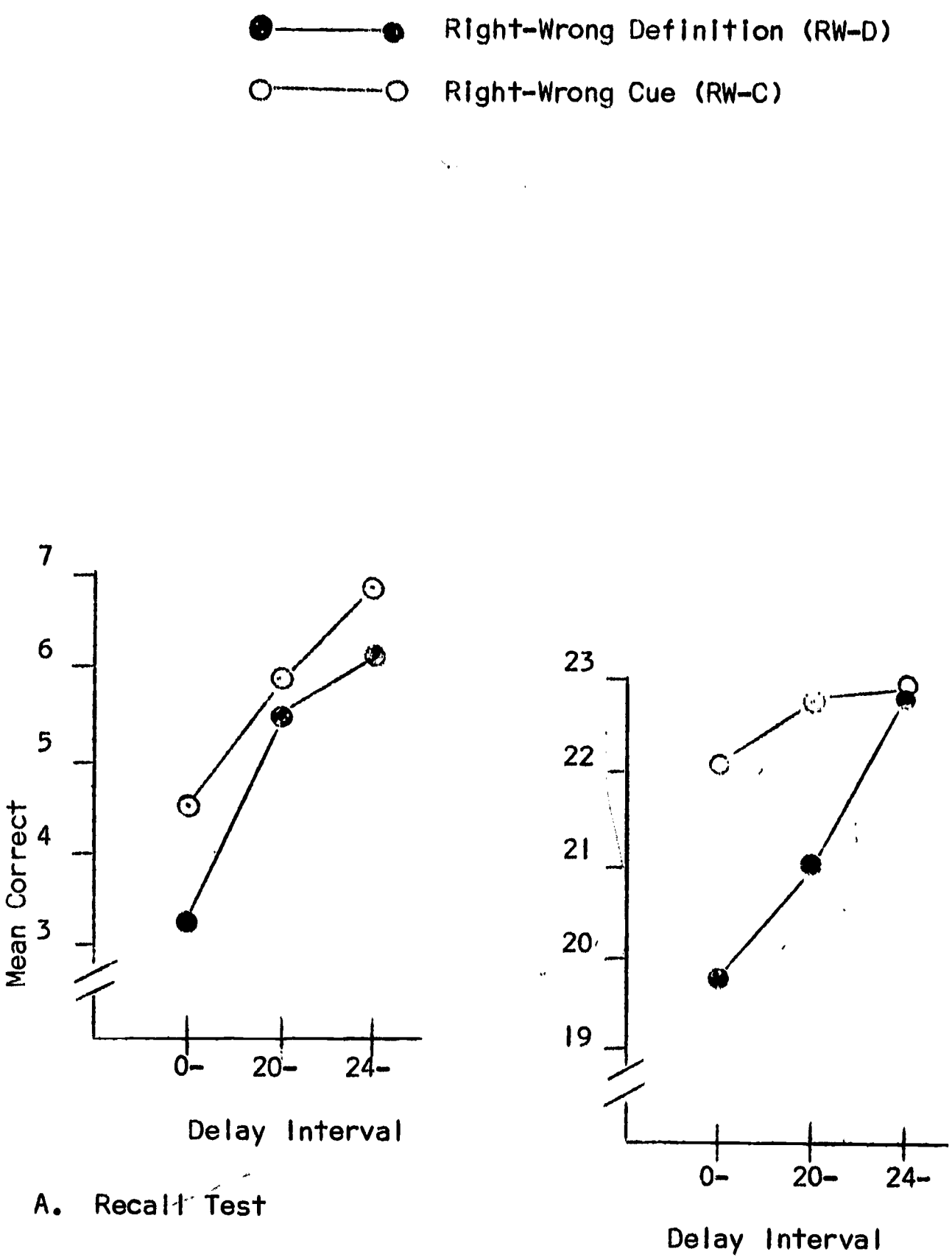


Fig. 6 Mean Correct, 7-day Retention Tests, Experiment II with Immediate Test Conditions Combined, for Delay Conditions and Two Forms of Feedback

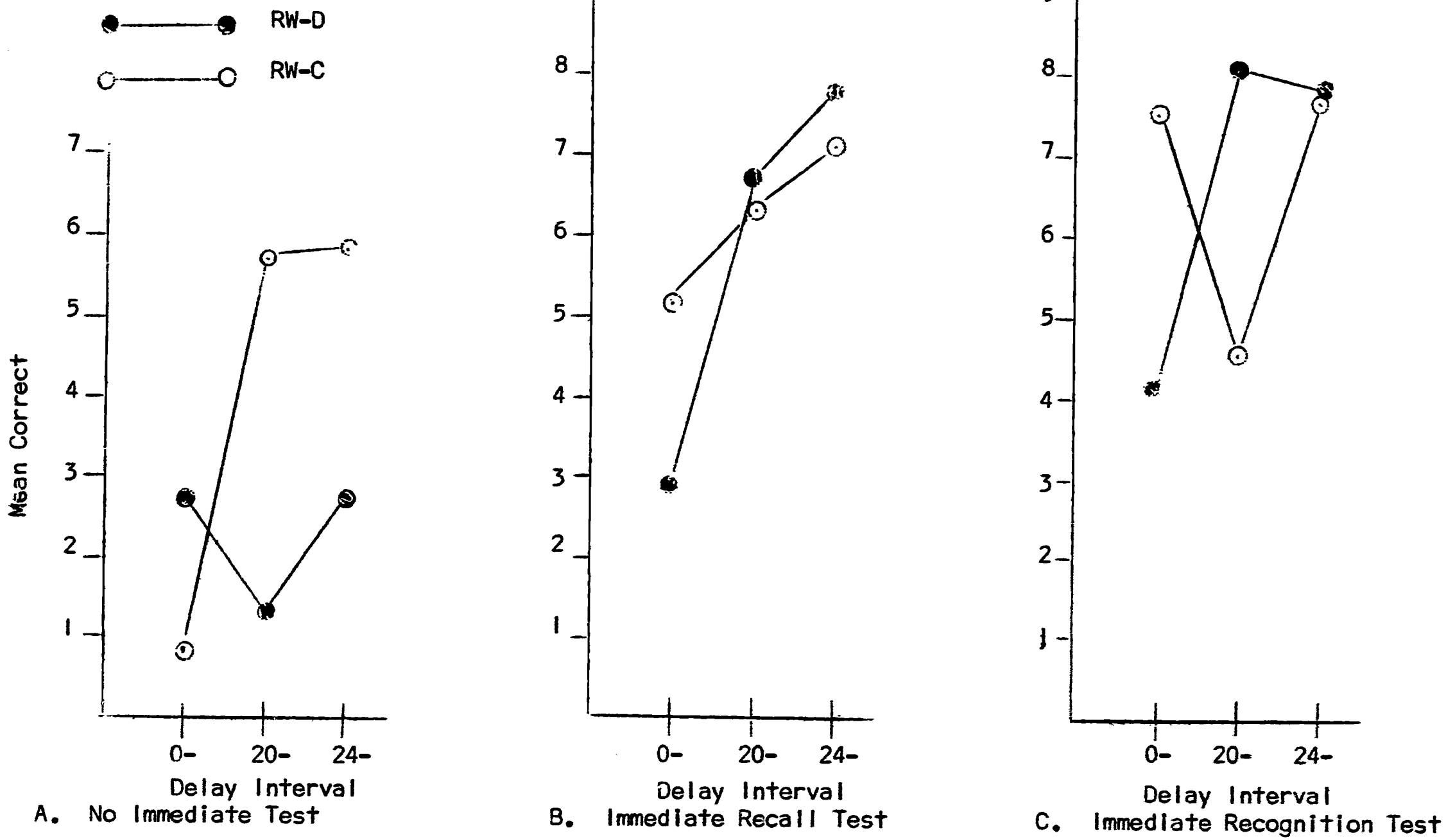


Fig. 7 Performance for 2 forms of feedback as a function of delay: 7-day Recall for each Immediate Test Condition, Experiment II

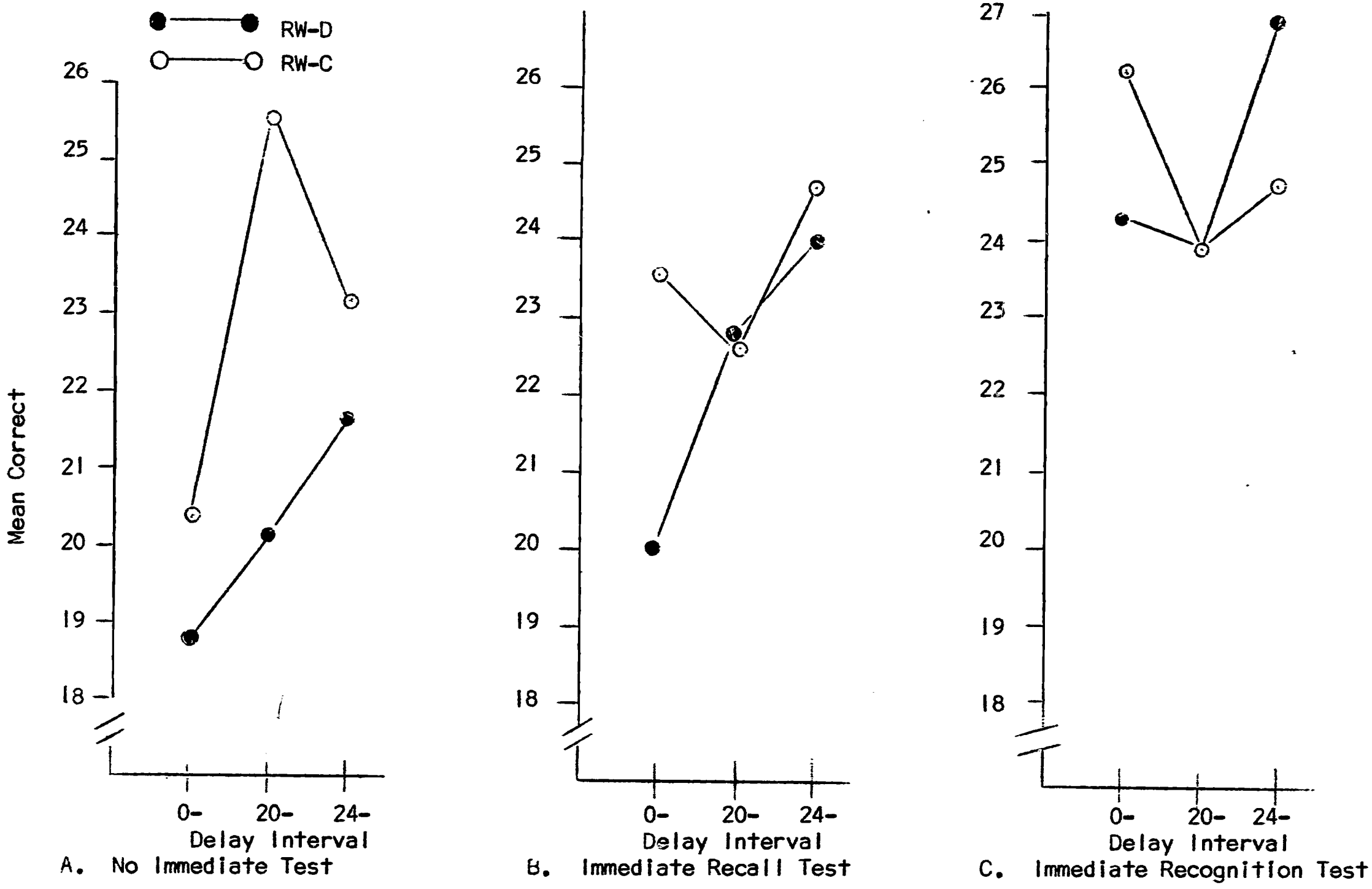


Fig. 8 Mean Correct, 7-day Recognition Tests, Experiment II: Delay, Feedback, and Immediate Test Conditions

Table 4

Summary Analysis of Variance, 7-day Retention Tests, Experiment II

Source	SS	df	MS	F
Feedback (F)	26.95	1	26.95	2.98
Delay (D)	78.76	2	39.38	4.36*
(24- + 20-) > 0 (D_1)	66.61	1	66.61	7.37**
Tests, Immediate (T)	273.68	2	136.84	15.15***
(Rcg-I + Re-I) > none (T_1)	193.75	1	193.75	21.44***
Rcg-I > Re-I (T_2)	79.93	1	79.93	8.85**
F x D	7.18	2	3.59	.39
F x T	25.85	2	12.93	1.43
D x T	31.62	4	7.91	.88
F x D x T	74.07	4	18.52	2.05
D_1 x T_1 x F	62.71	1	62.71	6.94**
error (between)	1463.71	162	9.04	
Retention Test (R)	6138.01	1	6138.01	4212.19***
F x R	1.81	1	1.81	1.24
D x R	2.96	2	1.48	1.02
T x R	42.99	2	21.49	14.75***
T_2 x R	42.08	1	42.08	28.88***
F x D x R	4.80	2	2.40	1.65
F x T x R	0.79	2	0.39	.27
D x T x R	5.34	4	1.33	.91
F x D x T x R	15.87	4	3.97	2.72
D_2 x T_2 x F x R	7.01	1	7.01	4.81*
D_1 x T_1 x F x R	7.44	1	7.44	5.11*
error (within)	236.06	162	1.46	

*$p < .05$
**$p < .01$
***$p < .001$

delay groups was essentially the opposite for the two forms of IF. When feedback was a cue (RW-C), the delay groups were superior only when there was no immediate test. Following an immediate test, when IF was a cue, 7-day retention with 0-min. delay improved and delayed feedback was no longer superior. In fact, under these conditions, 7-day retention with 0-min. delay did not differ appreciably from that for the delay groups with any form of feedback in either Experiment I or II.

When feedback identified the correct alternative and presented definitions of the incorrect (RW-D), delay was superior following the two immediate tests but not with no immediate test. This finding was similar to that in Experiment I for variable feedback, indicating that this effect does not require that the additional information be directly relevant to the test. One significant component of the four-way interaction between delay, form of IF, immediate test condition, and form of retention test (D x F x T x R) indicated that this latter effect with RW-D was greater on the 7-day recall test than on the recognition test. A second significant component of the interaction between delay, form of feedback, immediate test conditions, and form of retention test (D x F x T x R) indicated that the relative superiority of 24-hr. to 20-min. delay differed with the two forms of IF, and the form of both the immediate and 7-day tests.

Discussion

The results of Experiments I and II indicate that the effect of delayed feedback upon retention does differ with the form of feedback, and that this effect is dependent upon what happens immediately after acquisition, i.e., the immediate test condition. Which stimulus characteristics present at feedback are utilized to facilitate retention also depends upon both the immediate test condition and the delay interval. These results are consistent with the interpretation that after a delay interval Ss learn more at feedback, and that the retention of what is learned is affected by the immediate test.

What are Ss learning with delayed feedback that facilitates retention? In the different forms of feedback, different information in addition to the correct stimulus-response words was presented. However, the effect of this additional information may have been primarily to make more salient the correct alternative. In Experiment I there was no differential effect of delay for the two variable forms of IF, the correct alternative only or the correct and incorrect alternatives. Some evidence on the question of what is learned is provided by the kind of errors made on the recall test. The percentage of errors that were incorrect alternatives from the same item was computed. Figure 9 shows these data for the 7-day recall test in Experiment I. Again the immediate test conditions made a difference. Following an immediate recognition test there is a marked relationship between the percentage of errors of this kind, the delay interval, and form of IF. With 24-hr. delay there was an increase in percentage of errors that were incorrect alternatives when IF had included all alternatives. With 0-min. delay there was essentially no relationship between the kinds of errors and form of IF. These findings offer support for the interpretation that after a delay

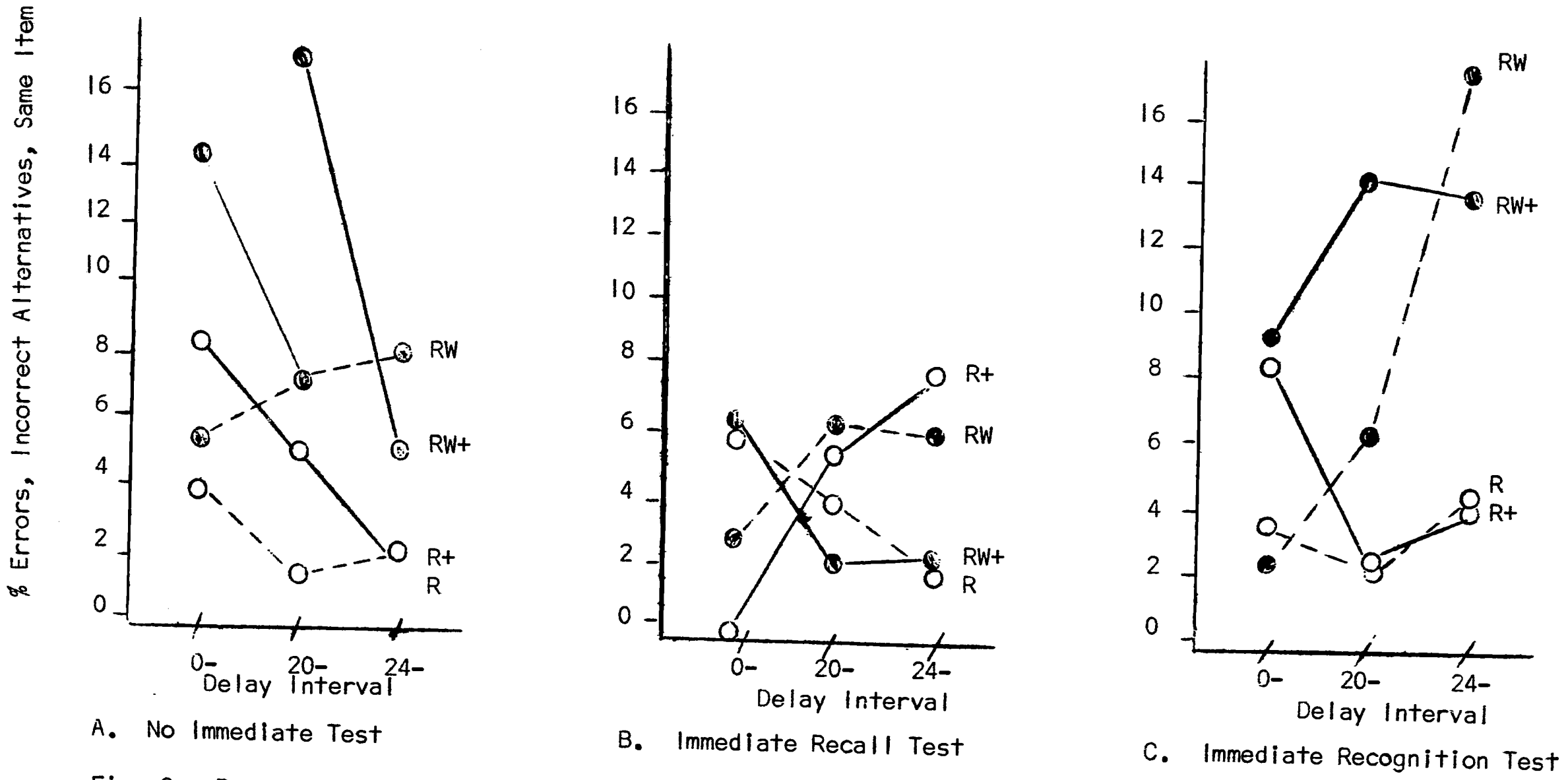


Fig. 9. Percentage of Errors, 7-day Recall Test, Incorrect Alternatives from Same Item, Experiment I for Delay Conditions, Form of Feedback, and Immediate Test Conditions

interval Ss acquire more information presented at IF and that the retention of what is learned is affected by the immediate test.

Two retention tests were used to provide evidence on what Ss are learning with delay of IF. Superior retention with delay, both overall and as a function of the form of IF, occurred on both a recall and recognition test, and in some conditions it was significantly greater on the recall test. Thus, the effect of delay is not due solely to improved discrimination among alternatives at a recognition level or to minimal retention, either of which would require the entire item to be presented. Rather, whatever is learned with delay is available with minimal cues at retention. The recall test was included as a measure more sensitive to organization of or among the alternatives, and the present findings provide some support for this assumption. In Experiment I overall performance on the 7-day recall test was best when IF consisted of all alternatives and on the 7-day recognition test when it was the correct alternative only. Thus, recall of the correct alternative to the stem word was facilitated when Ss had an opportunity to learn the incorrect in addition to the correct alternative. These findings suggest that retention of the correct stimulus-response words is facilitated when Ss have identified relations among the stem, the correct, and the incorrect alternatives.

Experiment II provides additional support for the hypothesis that superior retention with delayed IF is due to the information acquired at IF. When IF presented a cue which could be used to find the correct alternative, retention for Ss with immediate feedback was equivalent to that for Ss with delayed feedback with the correct alternative identified and additional information. With this form of IF, Ss would have to read the cue and the alternatives to find the correct alternative. Thus, it would be expected that they responded to all alternatives. Also, the cue itself could be used either as a direct associative link between the stem and the correct alternative or as a basis for organizing the units of the item, i.e., for identifying relationships between the stem and the correct alternative and/or the incorrect alternatives. Thus, when IF was such that Ss acquired additional information with immediate feedback, retention was equivalent to that found under other conditions with delayed feedback. These findings suggest that when IF is presented immediately item-by-item, Ss acquire the least information necessary to determine the correctness of their previous response. It is as though their response to IF is merely "I got that right," or "I got that wrong," and this may be primarily what they are learning. In order to improve retention it seems to be necessary that the presentation of IF be such that Ss acquire information about the item that is relevant to its retention. Apparently, this can be accomplished either by delaying the presentation of IF or by manipulating the form in which IF is presented.

The effect of the immediate test conditions upon the delay retention effect differed with the form of IF. In Experiment II when IF presented a cue, retention following delayed feedback was superior to that with immediate feedback only when there was no immediate test. However, even when IF directed Ss with immediate

feedback to respond to all information present at IF, retention was facilitated only when Ss had some immediate practice. Apparently when IF was a cue Ss with both immediate and delayed feedback acquire more information at IF. However, in order to use this additional information to facilitate retention of the correct alternative, it is necessary either that IF be delayed or that an immediate test follow IF.

In Experiment I with redundant forms of IF, where additional information was the same as on the initial presentation but not directly relevant to the recognition tests, the effect upon the delay retention effect was different following the immediate recall and recognition tests. According to the hypothesis that with delayed IF Ss acquire additional information presented at IF, the following interpretation is suggested. The additional redundant information acquired with delayed IF could not be utilized directly on the recognition test and thus there was no facilitation on later retention. However, with minimal cues on the immediate recall test, any additional information could be used to facilitate performance and later retention was improved. This interpretation is consistent with the finding that the overall superiority of delayed IF on the immediate tests was greater for the recall test than for the recognition test.

The present findings also indicate that when IF indicates the correct alternative and presents additional information that is not the same as that presented initially (Right Wrong-Variable and Right-Variable, Experiment I; Right Wrong-Definitions, Experiment II), optimal retention requires both a delay of IF and some immediate practice.

It was predicted that the immediate test would provide an opportunity for Ss with immediate feedback to acquire additional information and thus reduce the superiority of delayed feedback on later retention. As indicated above, the effect of the immediate test depended upon the information presented at IF and the relationship between this and the form of the immediate test. When IF was a cue, the effect of the immediate test was to improve retention for Ss with immediate feedback and thus decrease the delay retention effect as predicted. When IF indicated the correct alternative, the effect of the immediate test was to increase the delay retention effect.

According to these findings, it seems that when IF indicates the correct alternative, the effect of the immediate test following delayed feedback is to increase the Ss' utilization of additional information previously acquired at IF and thus later retention is improved. When IF indicates the correct alternative, Ss with immediate feedback do not acquire additional information at IF and thus the immediate test does not improve later retention.

Three delay intervals were included to help identify factors involved in the effect of 24-hr. delay of feedback. The present findings indicate that both the sequence of events and the length

and lack of experimental activity during the delay interval contributed to superior retention with delayed feedback. However, the sequence of events contributed more. Thus, it would seem that the effect of the longer delay interval is best interpreted as the effect of spacing of learning events. The optimal spacing of events, such as initial presentation of material, informative feedback, and tests, would depend upon a number of variables, some of which have been indicated here.

According to the present findings, the information presented at IF in combination with the delay of IF are important in determining how Ss respond to IF and what they acquire at the presentation of IF. The information acquired at the presentation of IF and the immediate test, as well as the form of this test, determine what Ss retain.

Experiment III

Experiment III investigated the question: can effects similar to those of delayed feedback be obtained by manipulating Ss' responses to feedback. Thus, there were no delay intervals compared. The Ss' reactions to IF were manipulated by the form of feedback and instructions. Three feedback conditions were compared to investigate the effect of: (a) learning the correct alternative; (b) learning the correct and the incorrect alternatives; and (c) organizing the material. In two of the feedback conditions, IF consisted of the entire item with the correct alternative indicated. Ss were instructed either (a) to study carefully the correct alternative; or (b) to study carefully both the correct and the incorrect alternatives. The third feedback condition was the same as the Right Wrong-Cue condition in Experiment II. It was expected that the cue should promote studying the relationships among the units of the item, and thus better organization of the material.

A second variable investigated the effects of the initial presentation with Ss answering each item and the interval preceding IF. Thus, in one condition Ss were presented the material, made a response, and received feedback. In the other condition, Ss received IF but with no initial presentation of the material or initial response to the items. As in Experiments I and II there were three immediate test conditions and 7-day retention was measured with both a recall and a recognition test.

Method

Design. Three variables were combined factorially: three forms of feedback [Instructions Right (I-R); Instructions Right Wrong (I-RW); and Right Wrong-Cue (RW-C)]; three immediate test conditions [(nothing; recall (Re-I); recognition (Rcg-I)]; and the presence or absence of the initial presentation and response preceding IF. All Ss had both 7-day retention tests, recall and recognition. Subjects were 180 undergraduates, randomly assigned with 10 Ss in each of the 18 groups.

Learning material. Learning material, initial presentation for the groups receiving this condition, and the tests were the same as in Experiments I and II. For the two instructions groups IF was the same as Right Wrong Variable in Experiment I, the stem

and all four alternatives in a randomly different position. For these two groups Ss were instructed at the presentation of IF (a) to study the correct alternative only as long as IF was exposed (Instructions Right); or (b) to study the correct and all incorrect alternatives while IF was exposed (Instructions Right-Wrong). For the Right Wrong-Cue groups feedback and instructions were the same as for this condition in Experiment II.

Procedure. For half of the groups, Ss were presented the material, made a response, and received IF for the appropriate condition. For these groups the sequence of events was the same as for the 20-min. delay condition in the previous experiments: the series of items was presented, followed immediately by the series of IF with the appropriate experimental instructions. For the presentation of the series of items, the temporal sequence was: item 1 (15 sec.); write the answer (15 sec.); item 2 (15 sec.). . . etc. For the remaining half of the groups, Ss received IF but with no initial presentation of the material or initial response to the items. For these three groups Ss were given the instructions and then the series of IF. For all groups the temporal sequence for the series of IF was: IF for item 1 (18 sec.); rest (10 sec.); IF for item 2 (18 sec.). . ., etc.

As in Experiments I and II the immediate tests were given immediately following the series of IF. All Ss returned seven days later for a recall test followed by a recognition test. For all tests the temporal sequence was identical to that in Experiments I and II.

Results

Immediate tests. Figure 10 presents the mean correct for each group for each of the tests. Table 5 presents the summary of the analysis of variance of these data. Performance was superior for Ss who received an initial presentation of the material compared with those who received IF only. Also, performance on the recognition test was superior to that on the recall test.

Seven-day tests. Figures 11 and 12 present the mean correct for each group for each of the tests. Table 6 presents the summary of the analysis of variance of these data. The effect of form of feedback was divided into two orthogonal components: F_1, RW-C vs. (I-R + I-RW); and F_2, I-R vs. I-RW. The effect of the immediate test conditions was divided into the same two components as in Experiments I and II; T_1, the combined tests (Re-I + Rcg-I) vs. no test; and T_2, Re-I vs. Rcg-I. The interaction between form of IF and immediate test conditions was determined on the basis of findings in Experiments I and II and was divided into the following components: $F_1 \times T_1$; $F_1 \times T_2$; $F_2 \times T_2$; and I-R vs. I-RW for the combined immediate tests (Rcg-I + Re-I).

As on the immediate tests, performance was superior for Ss who received an initial presentation of the material. Also, the overall effects of the immediate test conditions and the type of retention test were the same as in Experiments I and II. Retention was significantly better on the recognition test than on the recall test, and it was better following the combined immediate tests than with no

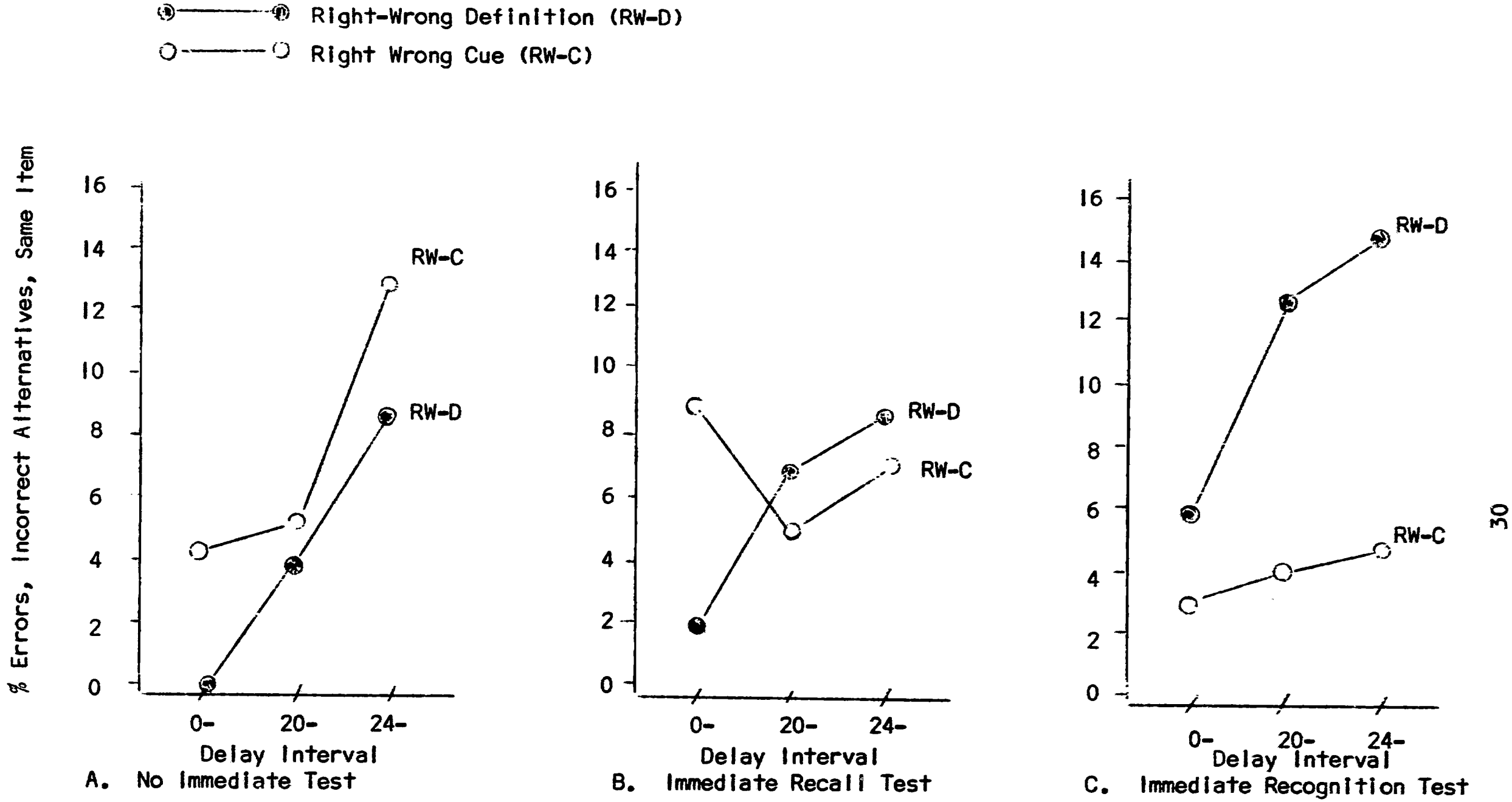


Fig. 10 Percentage of Errors, 7-day Recall Tests, Incorrect Alternatives from Same Item, Experiment II for Delay Conditions, Form of Feedback, and Immediate Test Conditions

Table 5

Summary Analysis of Variance, Immediate Tests, Experiment III

Source	SS	df	MS	F
Feedback (F)	9.83	2	4.91	< 1
Initial Presentation (IP)		1	127.10	28.43***
Test (T)	3075.47	1	3075.47	688.02***
F x IP	15.18	2	7.59	1.70
F x T	3.41	2	1.71	< 1
IP x T (Rcg-I > Re-I, no IP > IP)	17.25	1	17.25	3.86
F x T x IP	7.88	2	3.94	< 1
error	482.78	108	4.47	

***$p < .001$

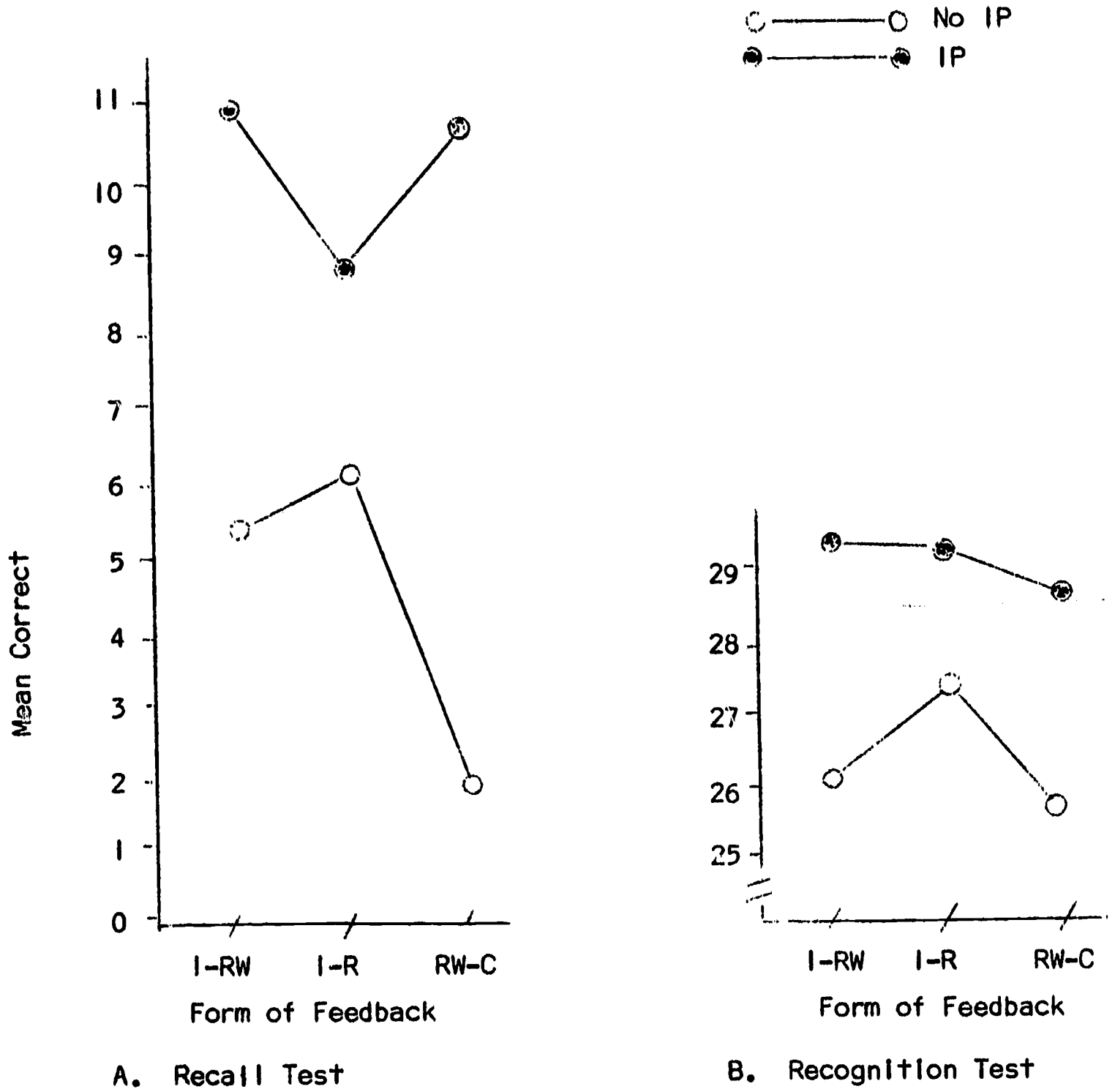
immediate test. Following the immediate recognition test retention was better than following the immediate recall test; and this effect was significantly greater on the 7-day recognition test than on the recall test.

One component of the interaction between form of feedback and immediate test condition (F x T) was significant. Retention for Right Wrong-Cue was superior to that for the combined instruction groups (I-R + I-RW) only when there was no immediate test. This finding is similar to that in Experiment II, when IF was Right Wrong-Cue, in which superior retention with delay of IF occurred only with no immediate test.

Also, one component of the interaction between form of feedback, immediate test condition, and form of retention test (F x T x R) was significant. For the combined immediate test conditions (Re-I + Rcg-I) retention on the 7-day recognition test was significantly better for Instructions-Right than for Instructions-Right Wrong; and on the recall test it was superior for Instructions-Right Wrong.

Discussion

The present experiment investigated the question, can effects similar to those of delayed feedback be obtained by manipulating Ss' responses to feedback. The effect of form of IF and immediate tests upon retention was similar to the effect of these variables upon the delay retention effect in Experiments I and II. That is, in this experiment retention was superior for those conditions for which



A. Recall Test

B. Recognition Test

Fig. 11 Mean Correct, Immediate Retention Tests, Experiment III for Forms of Feedback and Presence or Absence of Initial Presentation (IP)

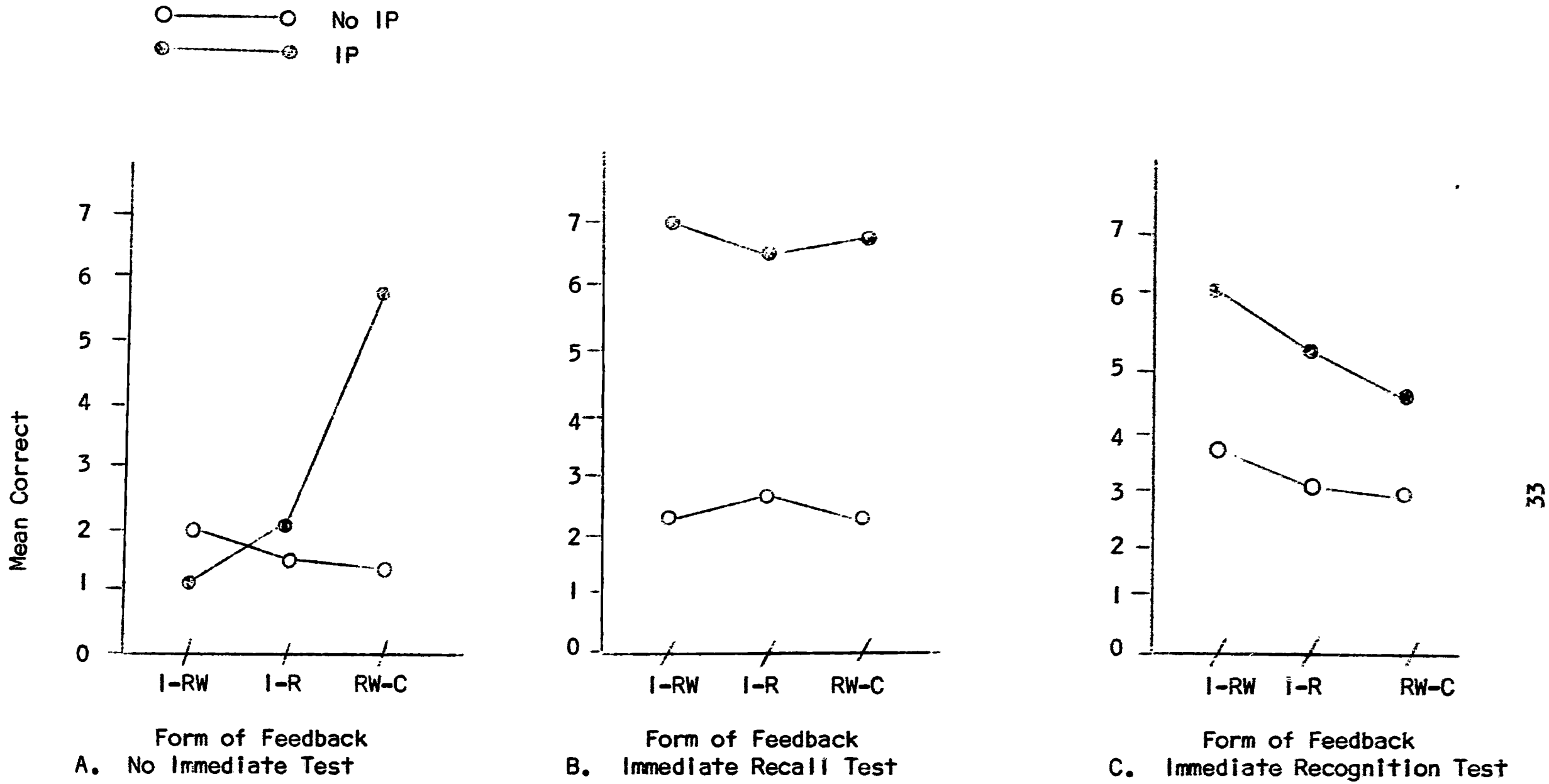


Fig. 12 Mean Correct, 7-day Recall Test, Experiment III for Immediate Test Conditions, Form of Feedback, and Presence or Absence of Initial Presentation (IP)

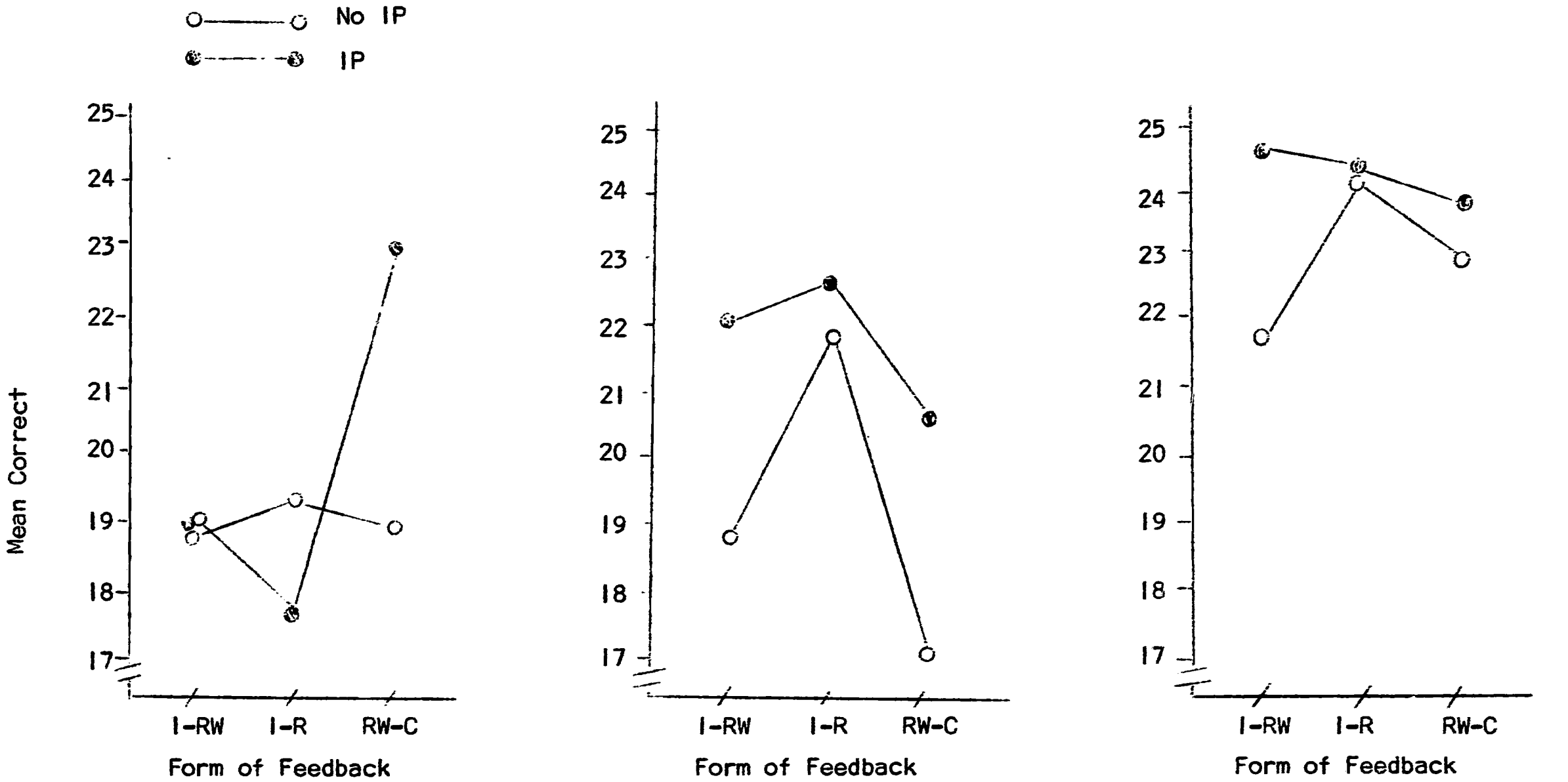


Fig. 13 Mean Correct, 7-Day Recognition Test, Experiment III for Immediate Test Conditions, Form of Feedback, and Presence or Absence of Initial Presentation (IP)

Table 6

Summary Analysis of Variance, 7-day Retention Tests, Experiment III

Source	SS	df	MS	F
Feedback (F)	1.55	2	0.78	< 1
Initial Presentation (IP)	95.58	1	95.58	14.82***
Tests, Immediate (T)	144.16	2	72.08	11.18***
(Rcg-I + Re-I) > none (T_1)		1	109.28	16.94***
Rcg-I > Re-I (T_2)		1	34.88	5.41*
F x T	46.33	4	11.58	1.80
RW-C > (I-RW + I-R) x T_1		1	42.03	6.51*
F x IP	18.16	2	9.08	1.41
F x T x IP	27.39	4	6.85	1.06
$F_1 \times F_2 \times$ IP		1	24.28	3.76
error between groups	1045.59	162	6.45	
Retention Test (R)	6974.00	1	6974.00	3452.48***
R x IP	6.01	1	6.01	2.98
R x F	5.17	2	2.59	1.28
R x T	40.90	2	20.45	10.12**
$T_2 \times R$		1	39.62	19.61***
F x R x IP	6.32	2	3.16	1.56
T x R x IP	1.84	2	0.92	< 1
F x T x R	14.19	4	3.55	1.76
(Rct-I + Re-I) I-RW vs I-r x R		1	8.56	4.23*
F x T x R x IP	0.76	4	0.19	< 1
error within groups	327.44	162	2.02	

*$p < .05$
**$p < .01$
***$p < .001$

delayed IF was superior to immediate IF in Experiments I and II. When IF was a cue retention was superior only when there was no immediate test; and when IF indicated the correct choice retention following immediate tests was superior to that with no immediate tests.

Overall retention for Ss instructed to study the incorrect in addition to the correct alternatives was not superior to that for Ss instructed to study the correct alternative only. Instructing Ss to respond differently at the presentation of IF did affect their retention performance but this effect depends upon the form of the retention test as well as the presence of an immediate test. The fact that retention on the recognition test was superior when Ss had been instructed to study the correct alternative only and on the recall test when they had been instructed to study the incorrect as well as the correct alternative is consistent with the results of Experiment I. In that experiment performance on the recognition test was superior when IF presented the correct alternative only and on the recall test when IF presented the incorrect in addition to the correct alternative. Thus, it appears that Ss did respond to IF as they were instructed to. These findings add more support to the conclusion that recall of the correct response alternative is facilitated when Ss have had an opportunity to identify relations among the stem, the correct, and the incorrect alternatives. Also, they support the interpretation that when Ss acquire more information at IF, some immediate practice is necessary for them to utilize this to facilitate retention; and additional information is most facilitative when retention occurs with minimal cues.

Overall retention, both immediate and at seven days, was superior when Ss had an initial presentation of the material and wrote their response to that when they received IF only. However, the effect of the other variables did not differ with the presence or absence of the initial presentation. Thus, it would seem that retention is facilitated by two presentations of the material and that this facilitation is independent of the form of the retention test, the immediate test conditions, or the Ss' response to feedback.

As in Experiments I and II, overall retention at seven days was better following an immediate recognition test that after an immediate recall test. However, in every experiment facilitation of the immediate recognition test was greater on a later recognition test than upon a later recall test. Performance on the 7-day recall test was just as good following an immediate recall test, even though the mean number of correct responses given on the immediate recall test was markedly less than that given on the immediate recognition test. Apparently, immediate identification of a greater number of correct alternatives does not result in substantial improvement in later recall of the correct alternatives.

Conclusions and Recommendations

Conclusions

According to the present findings, the following conclusions are indicated. The effect of 24-hr. delay of IF differs with the form of IF, the presence and form of immediate tests, and the form of retention tests. Immediate retention, or acquisition, is improved by delayed feedback when retention occurs with minimal cues and when IF indicates the correct alternative. When IF indicates the correct alternative and presents additional relevant information, long-term retention is facilitated when presentation of IF is delayed and when there is some immediate practice after IF. When IF presents a cue which Ss can use to find the correct alternative, optimal retention requires either that presentation of IF be delayed or that immediate presentation of IF be followed by some immediate practice.

Superior retention with delayed IF is greater when retention occurs with minimal cues. Also, when Ss acquire more information at IF some immediate practice is necessary for them to utilize this to facilitate retention; and additional information is most facilitative when retention occurs with minimal cues.

These findings are consistent with the interpretation that superior retention with 24-hr. delay of feedback is due to factors operating at and/or following the presentation of IF and that what Ss learn with immediate and delayed feedback actually differs. More specifically, they are consistent with the hypothesis that with delayed feedback Ss respond to more cues or stimulus aspects of IF, thus learning more about the item; and that when these cues can be used in retention, delay improves retention.

The present findings indicated that the relative superiority of delayed feedback on retention could be changed by manipulating the form of IF and the Ss' response to IF. When there had been an immediate recognition test, the following relationships were demonstrated on 7-day retention. When IF indicated the correct alternative and was presented in a form different from that of the initial presentation, delayed feedback was superior to immediate. When IF was presented in the same form as on the initial presentation, which was not the same as on the recognition test, retention with delayed feedback decreased and was not superior to immediate. When IF was a cue which could lead S to explore all alternatives, retention with immediate feedback improved and did not differ from that with delayed feedback. Following an immediate recall test, retention with delayed feedback was superior when IF indicated the correct alternative whether IF was presented in the same or different form from that of the initial presentation.

The present findings also have implications for understanding factors affecting long-term retention of meaningful material. Presentation of IF and tests function primarily as learning trials, and the effect of learning events upon long-term retention depends upon the conditions of retention. For optimal retention under conditions of minimal cues, mere repetition of the response to the stimulus word is not sufficient. Rather, long-term retention is

improved when conditions are such that Ss identify relationships between the to-be-remembered units and other possible alternatives. Perhaps a kind of network is developed in which the correct response is integrated with incorrect alternatives; and long-term retention is better when there is such a network than when Ss have acquired the correct alternative only. According to this interpretation, the spacing of learning events and the information presented at informative feedback and immediately following it would be important in providing opportunity for the development of such a network. Optimal retention under conditions in which many cues are present is not so dependent upon organization of the material. However, even in this case retention is facilitated when learning conditions are such that some exploration of the material occurs.

Recommendations

The results of these experiments have some direct implications for educational practices. One general goal of education is that the learning acquired be available for long-term retention and that it be available under conditions of minimal cues. Thus, educational practices should optimize long-term retention with conditions more similar to a recall test than to recognition or relearning tasks. Following are a few recommendations for educational practices, which follow from these findings:

1. The immediacy or delay of presentation of information about the correct alternative is not so important as what occurs at the presentation of this information. If this informative feedback is to improve long-term retention, the first requirement is that it be presented under conditions to assure that the student responds to the information provided and not just to determine the correctness of his previous response. This may be accomplished by directly utilizing some of the procedures in these experiments or in some other way appropriate to the situation.

2. Retention, especially under conditions of minimal cues, will be better if the student learns the correct response in a context including more than just that response. This may be accomplished by presenting the correct response along with a number of other possible alternatives, which are not correct. Also, it may be done by presenting information that tells the student why it is correct.

3. The spacing and form of test or practice activities should be determined on the basis of the amount and kind of information a student has acquired previously. Although it is not indicated in the present experiments, it would be expected that the amount and kind of information a student can utilize would vary with his level of abilities. Also, this would be expected to depend upon his habitual way of responding to information presented. Thus, one goal in helping students improve retention is to help them to learn to acquire and to use information in addition to the correct response.

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Appendix A

Sample Item and Different Forms Informative Feedback, Experiments I and II

Initial Presentation:

```
"TO CLEAR FROM BLAME"
  a.  EXCULPATE
  b.  LUCUBRATE
  c.  LIBRATE
  d.  PROPITIATE
```

Informative Feedback: for Experiment I:

RW+ Right + Wrong - Redundant
Same Position + letters

```
"TO CLEAR FROM BLAME"
 *a.  EXCULPATE
  b.  LUCUBRATE
  c.  LIBRATE
  d.  PROPITIATE
```

R+ Right only - Redundant
Same Position + letter

```
"TO CLEAR FROM BLAME"
 *a.  EXCULPATE
```

RW Right + Wrong - Variable
Randomly different position -
no letters

```
"TO CLEAR FROM BLAME"
     PROPITIATE
     LIBRATE
   * EXCULPATE
     LUCUBRATE
```

R Right only - Variable
Randomly different position -
no letter

```
"TO CLEAR FROM BLAME"

     * EXCULPATE
```

Informative Feedback: for Experiment II:

RW-D Right + Wrong - Definitions

```
"TO CLEAR FROM BLAME"
    LIBRATE (vibrate)
    PROPITIATE (pacify)
    LUCUBRATE (study laboriously)
  * EXCULPATE
```

RW-C Right + Wrong - Cue

```
"TO CLEAR FROM BLAME"
      LUCUBRATE
      EXCULPATE
      PROPITIATE
      LIBRATE
(EX = OUT; CULP = GUILT,
 AS IN CULPRIT)
```

Tests, Experiments I and II:

Recall:

```
"TO CLEAR FROM BLAME"
```

Recognition:

```
"TO CLEAR FROM BLAME"
    PROPITIATE
    EXCULPATE
    LUCUBRATE
    LIBRATE
```

Appendix B. Temporal Sequence of Events for the Three Delay Conditions, Experiments I and II

<u>0-min. Delay:</u>

Session I:

Item 1 15 sec.	Write Answer 15 sec.	IF, 	Item 1 15 sec.	Rest 10 sec.	Item 2 . . . 15 sec.	Item 32 . . . 15 sec.	Answer IF, 15 sec.	Item 32. . . 15 sec.	Immediate Test . . .

7 days later: Recall Test; Recognition Test

<u>20-min. Delay:</u>

Session I:

Item 1 15 sec.	Write Answer 15 sec.	Item 2 . . . 15 sec.		Item 32 Answer // 15 sec. 15 sec.//	IF, Item 1 15 sec.	Rest 10 sec.	IF, Item 2 . . . 15 sec.		Immediate Test . . .

7 days later: Recall Test; Recognition Test

<u>24-hr. Delay:</u>

Session I:

Item 1 15 sec.	Write Answer 15 sec.	Item 2 . . . 15 sec.	Item 32 Answer // 15 sec. 15 sec.//	IF, Item 1 15 sec.	Rest 10 sec.

Session 2 (24-hrs. later):

IF, Item 2 . . . 15 sec.		Immediate Test . . .		

7 days after Session 2: Recall Test; Recognition Test

<u>All Three Delay Conditions: Immediate and 7-day Recall and Recognition Tests</u>

Item 1 15 sec.	Write Answer 15 sec.	Item 2 . . . 15 sec.	

NOTE: In all conditions, <u>S</u>s had the same number, type, and length of presentation of all material.